Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

OCTOBER, 1915.

EUTECTICS.

By J. L. HAUGHTON, M.Sc., and D. HANSON, M.Sc.

THERE is perhaps no method of investigation which has advanced our knowledge of the constitution of metals and alloys so much as that which is known by the name of "thermal analysis." By this we mean the accurate observation of the heat changes which occur when the substance under investigation is cooled from the liquid state. The change of any pure substance from the liquid to the solid state is accompanied by a change in the energy content which makes itself manifest by an evolution of heat, so that the temperature remains constant during the whole time of solidification. The detection of this temperature is a matter of great simplicity, and is capable of extreme accuracy. All that is necessary is the observation of the temperature of the cooling mass at regular intervals of time; or, better still, of the rate of cooling over successive equal intervals of temperature, from a point above the melting-point. The second of these methods is the one which is most frequently used, for reasons which, however, cannot be discussed here. The substance cools, under suitable conditions of working, at an approximately constant rate until the melting-point is reached, when the rate falls off suddenly, and becomes practically zero until the solidification is complete, after which it again cools, in the case of most pure substances, without any further evolution of heat-energy down to atmospheric or any other convenient temperature. Figure 259 gives the graphical representation of such observations on the melting-point of zinc. The times taken to cool over successive intervals of 0°·2 C. are plotted as abscissae, and the temperatures are plotted as ordinates. The large peak in the "cooling curve" represents the heat evolution at the point of solidification.

Now let us consider what happens when we cool a solution, and, as an example, let us take the simple case of common salt and water. It is a

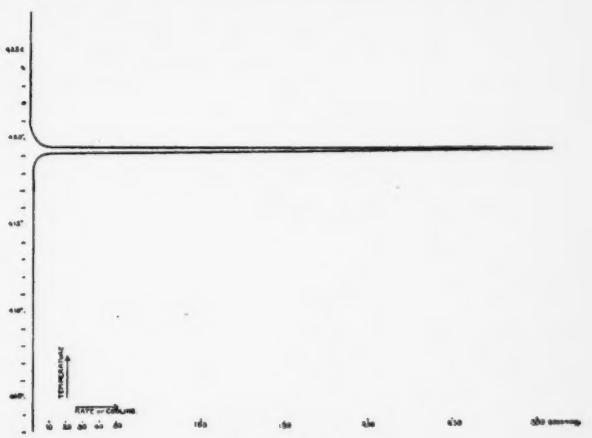

FIGURE 259.

matter of universal knowledge that the addition of small quantities of salt to pure water lowers the freezing-point, *e.g.*, the sea remains liquid when rivers and freshwater lakes are frozen. This being so, we must expect that solidification will not begin until the temperature of the solution has fallen below 0° C. If, however, we continue to cool the solution for some distance below that temperature

at which freezing begins, we find that the presence of the salt is responsible for something more than a simple lowering of the freezing-point. A five-per-cent. solution, for example, begins to solidify at about −2° C.; but, on cooling further, we find that another "peak" or "arrest" appears in the cooling curve at a temperature of −22° C. A solution containing ten per cent. of salt begins to solidify at −4°·5 C., and the second arrest begins again at −22° C. As the concentration of salt is increased, the temperature of initial freezing falls, while the temperature of the second arrest remains constant. This continues until we reach a concentration of twenty-three per cent. of salt, when

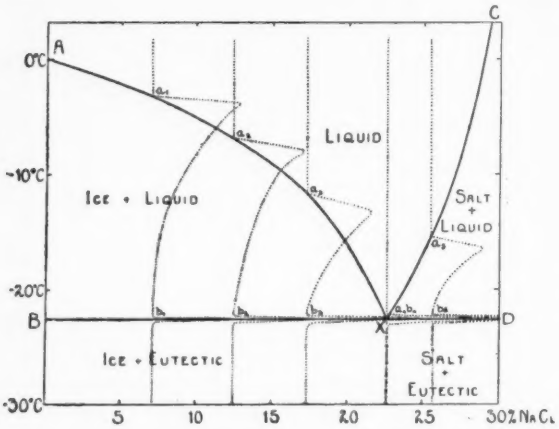

Figure 260.

the two points coïncide, and we have a solution with only one arrest on its cooling curve, namely, at −22° C. At a still greater concentration another arrest-point appears at a higher temperature, and the point of initial freezing now rises rapidly with the salt concentration.

Let us plot such a series of curves (see Figure 260), arranging them so that their horizontal distance from the origin 0 is proportional to the percentage of salt in the solution. The points *a* 1, *a* 2, *a* 3, and so on, represent the points of initial freezing; while the points *b* 1, *b* 2, *b* 3, and so on, represent the constant temperature arrest at −22° C. It will be seen that the line AXC is the locus of the points of initial freezing, while the line BXD is the constant arrest at −22° C. The diagram obtained in this way is known as the "constitutional diagram."

Let us suppose that we remove the crystals which first separate from the cooling liquid. These, on examination, are found to be pure ice, containing no salt; and it follows that the liquid which is left (known as the "mother liquor") will be richer in salt, the composition at any temperature being that at which the temperature ordinate on the diagram cuts the line AXC. Further cooling of the mother liquor results in the further deposition of ice, until the temperature falls to −22° C., when the composition will be represented by the point X, the lowest point on the curve. The mother liquor then solidifies at a constant temperature as an intimate mixture of ice and salt. This mixture is known as "the eutectic mixture," or simply as "the eutectic," of the series, and the point X is known as "the eutectic point." Mixtures which contain less salt than the eutectic mixture will, when solid, consist of ice crystals embedded in the eutectic. Those containing more salt will, on the other hand, consist of salt crystals similarly embedded, while the solution containing 23 per cent. of salt will consist of pure eutectic.

The word "eutectic," which is derived from the Greek εὔτηκτος (easily fusible), was applied to these alloys by Guthrie in 1875, and the name may be given to any alloy which fulfils the following conditions:—

1. It has a lower melting-point than the adjacent alloys.
2. It freezes at a constant temperature.
3. It has a constant composition.

The fact that these intimate mixtures fulfil the last two conditions led to the supposition that they were chemical compounds, and this was only disproved when it was discovered that the elements were not present in any definite *molecular* proportions. Furthermore, the appearance of an eutectic under the microscope is a proof that it is not a compound, but a mixture.

We are now in a position to consider the eutectiferous series of alloys, and the part they play in the metals of common use. First of all, let us consider the simplest type of eutectiferous series of alloys, and, as an example, the antimony-lead series. The constitutional diagram of this series is given

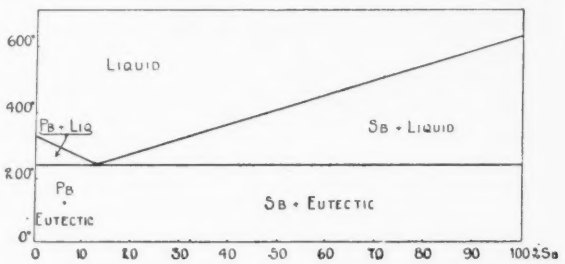

Figure 261.

in Figure 261. Let us take three typical alloys in this series, namely, those containing ten per cent., thirteen per cent., and forty per cent. of antimony respectively. It will be seen from Figure 261 that the alloy containing ten per cent. of antimony should consist of lead crystals embedded in a ground mass of eutectic; the alloy containing forty per cent. of antimony of crystals of antimony similarly embedded; and the alloy with thirteen per cent. of antimony should consist entirely of eutectic. The correctness of these conclusions is confirmed by a microscopic examination, the alloys being shown

FIGURE 262. Lead with 10 per cent. of antimony.

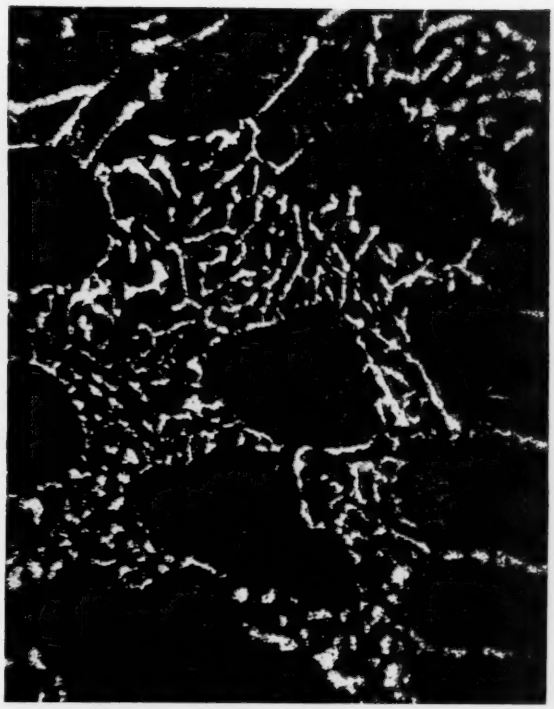

FIGURE 263. Lead with 40 per cent. of antimony.

FIGURE 264. Lead with 13 per cent. of antimony.

FIGURE 265. Iron and Carbon—"Pearlite."

PHOTO-MICROGRAPHS OF ALLOYS.

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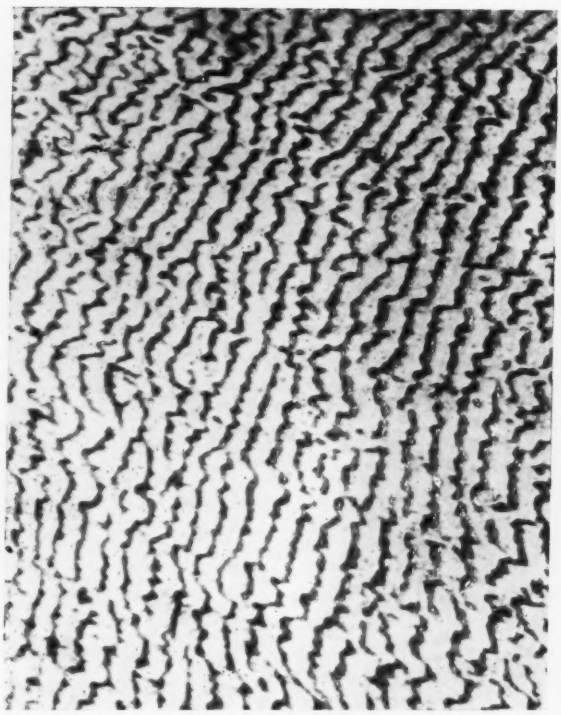

FIGURE 266.
Lead with 63 per cent. tin.

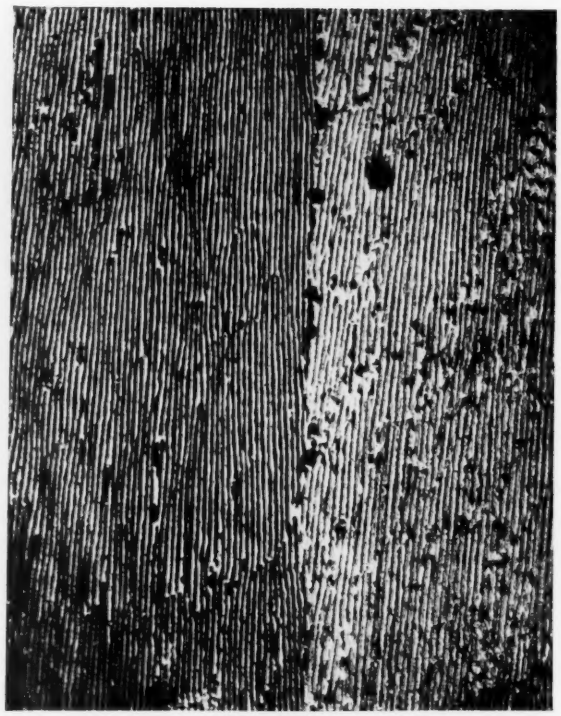

FIGURE 267.
Lead with 63 per cent. tin.

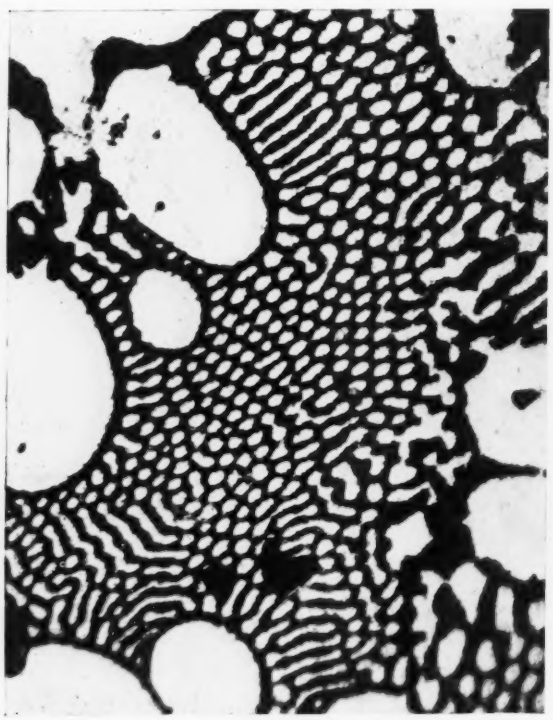

FIGURE 268.
Globular Eutectic (copper aluminium).

FIGURE 269.
Polygonal Eutectic (copper antimony).

PHOTO-MICROGRAPHS OF ALLOYS.

in Figures 262 to 264 under a magnification of one hundred diameters. The characteristic appearance of the eutectic is clearly seen in all three figures: it consists of alternate layers of lead and antimony, the dark bands consisting of lead, and the light ones of antimony. Figures 266 and 267 show the same type of structure in the lead-tin alloys.*

Although some eutectics depart somewhat from this lamellar structure, it may be said to be the typical eutectic appearance, the divergences being more apparent than real. Occasionally microscopic examination shows the eutectic to consist of globules of one metal in a matrix of the other, these globules being generally arranged in a regular pattern. Again, one of the metals may exist as small regular polyhedra, the ground mass consisting, as before, of the other metal (see Figures 268 and 269).

Whichever of these forms the eutectic may take, it consists of an intimate mixture of the two constituents, and this appearance is very easily recognised.

Rosenhain has shown that an eutectic is built up of small, possibly ultra-microscopic, units, which are arranged along lines radiating from a centre, the units along each line facing in the same direction. Such a structure suggests that each of the eutectic "grains" is a spherulitic crystal. This would indicate that the solidification of each crystal must have proceeded from a centre, and that the separate units of each grain are not independent crystals. He also suggests that one of the constituents plays the part of predominant partner, the other partner being forced to solidify in the interstitial spaces.

So far we have assumed that the eutectic consists of juxtaposed layers of two *pure* metals; more usually, however, we have to deal with "solid solutions," since most metals are mutually soluble in the solid state, though sometimes only to a very slight extent, and in such cases the two constituents of the eutectic are these solid solutions. Furthermore, should a chemical compound be formed, this may be one of the constituents of the eutectic.

In certain systems of alloys more than one eutectic may occur, but it should be pointed out that this can only happen when the two metals form a chemical compound. Thus, for example, the metals magnesium and tin form a compound Mg_2Sn, and the compound forms one eutectic with magnesium and another with tin. In effect, we are dealing with two systems of alloys: those of magnesium with the compound, and those of the compound with tin.

A particularly interesting example of this multiplicity of eutectics is found in the alloys of gold with magnesium. These two metals form three compounds, which give rise to four eutectics. Figure 270 shows the constitutional diagram of these alloys, the eutectic points being marked A, B, C, and D.

There is another class of bodies which shows all the characteristics of eutectics, with the exception of the method of formation, and in this respect it differs only in that it is formed after the metal has become solid, and not at the time of solidification. To distinguish this class of alloys from true eutectics, they have been given the name of "eutectoids."

For the sake of simplicity, we have as yet only referred to eutectics of binary alloys, *i.e.*, alloys containing two metals only. As a matter of fact, however, alloys containing three, four, or even

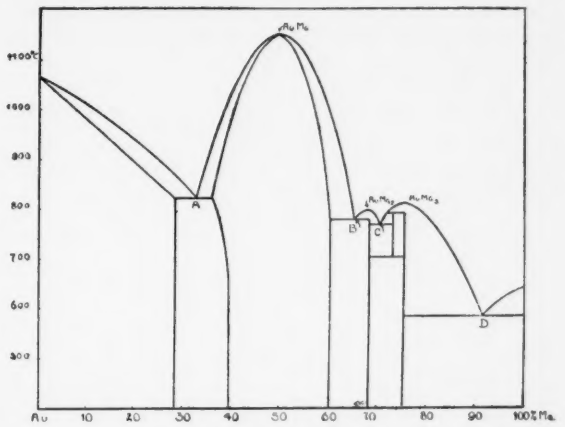

FIGURE 270.

five metals are frequently met with in practice. In such cases we may find alloys containing more than one eutectic, and eutectics containing more than two constituents. Such cases, however, are too complex for detailed discussion.

Eutectic alloys play a considerable part in the metals of common use. By far the most important is the eutectoid of iron and carbon, to which the name "pearlite" has been given. This is met with in nearly all the steels of commerce, and imparts to them combined strength and ductility. It consists of alternate layers of pure iron (ferrite) and a carbide of iron (cementite), having the formula Fe_3C. Figure 265 shows the characteristic lamellar structure of pearlite under a magnification of one thousand diameters.

Eutectics also play an important part in certain white bearing-metals, which consist essentially of hard particles embedded in soft matrix. The latter is generally an eutectic.

Type metal is also composed largely of a ternary or quaternary eutectic, as are also the so-called fusible alloys, some of which melt considerably below the boiling-point of water.

* Reproduced by kind permission from Rosenhain and Tucker's paper on the "Alloys of Lead and Tin" (*Phil. Trans.*, A, Volume CCIX, 1908, page 85).

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THE CONFERENCE OF DELEGATES OF CORRESPONDING SOCIETIES OF THE BRITISH ASSOCIATION, MANCHESTER, 1915.

Two successful meetings of the Conference of Delegates of Corresponding Societies were held during the Manchester meeting of the British Association. At the first the President, Sir Thomas H. Holland, K.C.I.E., D.Sc., F.R.S., delivered the following address on

"THE ORGANISATION OF SCIENTIFIC SOCIETIES."

Among the many lessons we learn in every great war there is always one that stands out prominently as something of fundamental and national importance. In the Crimea our shortcomings in commissariat organisation were demonstrated with painful emphasis. In South Africa we learnt something of the way in which the initiative of the individual, naturally more prominent in the amateur soldier, triumphs, under unforeseen circumstances, over any system fixed by formal and traditional discipline. The great war now in progress will result more completely than any of its puny predecessors in recasting our national ideals, economic, political, and military.

Of all the lessons we are likely to learn, the one that so far promises most to affect the life of the nation may be summed up in the word *organisation*. The fuss made lately about the shortage of munitions; the discovery in the ranks of the Army, and among its officers, of thousands who are only amateur fighters, but are professionally trained technologists; the recasting of the Cabinet; the introduction, twelve months after the commencement of the war, of legislation to register and classify the technical qualifications of the people; the repeated occurrence of coal strikes on a large scale, settled only by the intervention of Cabinet Ministers, and by an obviously temporary compromise, are all confessions of our shortcomings in national organisation—shortcomings that have cost the country thousands of lives.

On the other side of the "front" we see organisation raised to the level of a national cult—*Kultur*—with the result that, while efficiency in action and economy in the utilisation of a country's resources have been raised to a standard hitherto unknown, and by us undreamt of, the human instincts have been drilled out of existence, and Germany stands alone as an almost perfect machine in action, but, like a machine, unable to understand the rest of the human race—admired for its mechanical efficiency, but loathed for its degradation of the great human instincts of liberty and toleration.

But between these extremes there must be a course of maximum wisdom; for admittedly both the organisation of the community (the feature which is supposed to dominate the professional classes) and freedom of the individual (the prerogative of the amateur) are necessary for the progress of what is best in civilisation.

Every meeting of the British Association reminds us that early in the last century a body of learned men realised that the form of study popularly known as scientific needed organising, required the strengthening influence of a protective guild—the formation of a cult—in order that its value might be forced on the popular mind. Long before the foundation of the British Association, a comparatively small number of men had interested themselves in scientific problems, and their work had so far progressed as to require specialisation, with the foundation of distinct societies. This specialisation found expression at the first three meetings of the Association by the formation of committees for (1) Mathematics and General Physics, (2) Chemistry and Mineralogy, (3) Geology and Geography, (4) Zoölogy and Botany, (5) Anatomy and Physiology, and (6) Statistics.

These six groups have developed into our present twelve Sections, with extra Sub-Sections; and in practice every Section, by classification of its papers, and in the conduct of its discussions, acknowledges a further specialisation that is none the less real because it has not yet been formally recognised in organisation.

It is difficult for us to realise that, although the collection of scientific data and thought had made such progress eighty-four years ago as to require the sub-division indicated by the first institution of the British Association, the importance of science was still hardly recognised among the so-called learned and the ruling classes. Obvious, if insufficient, progress had been made since the days when it was possible for Dean Swift to issue, as tolerable literature, his satires on the Royal Society, or for Robert South to add to his doubtful popularity by describing its members as incapable of admiring anything except "fleas, lice, and themselves."

Although science now takes its place on equal terms with literature in the world of academic culture, we have so far succeeded only to a very small extent in getting the professors of pure science to coöperate in unison with the captains of industry who depend entirely, consciously or otherwise, on the application of scientific laws to industrial problems.

There has hitherto been a tendency for scientific and literary men to gather together under one banner, with the motto "learned," but a more natural association should be indicated by the community of interests between scientific men and technical experts. The student of pure science often discovers laws or formulates theories which are but accidentally carried beyond the purely intellectual world. On the other hand, technical experts frequently work by empirical methods that are discovered either by accident, or as the result of many costly blunders. The growth of science and of commercial technology have been largely independent and unrelated, that is, without organisation.

The absence of this organisation has shown itself for many years to those who are able to read the signs of the times by the way in which German applied science has assisted commercial activity in trespassing on markets created and formerly occupied by British enterprise. The result of organised coöperation on the one hand, and of disconnected effort on the other, has now been brought home to us all, suddenly and painfully, by the war. In the utilisation of technical science the German Army has had an enormous advantage, for which we have had to pay by the lives of some of our best officers and men.

In Germany the scientific, technical, and commercial community (not communities) is mobilised, and each individual in it has been given his appropriate function. In this country, on the other hand, we still have endless instances of right men in wrong places, while scientific activity seems to be devoted to the voluntary formation of innumerable and often irresponsible committees, with overlapping functions, and with no apparent common aim in view. Nothing could more clearly demonstrate our shortcomings in organisation than the columns of the daily press, which are filled with complaints from scientific men, who, though among the most distinguished in the

world of pure science, are in this great struggle still unemployed, and unfortunately often show by the tone of their complaints that they are also unemployable.

A small fraction of the time now devoted in this country to discussions in committee would be sufficient, if turned to well-directed effort, to remove many of the handicaps from which our Navy and Army are now suffering in this critical stage of the war. Most committees might be justifiably likened to two athletes at the east end of a church discussing the better route by which to get around to the tower, while a cripple starts off at once by one of the routes (possibly even by the less easy of the two); yet the cripple gets there while the athletes are still wrangling.

The root trouble with us is due to the fact that our committees are generally composed of members appointed, not because they are best able to solve the problem in hand, but because they represent vested interests; and vested interests have now grown to dimensions beyond power of removal, because our institutions are often the products of worthy, local, unconnected, and therefore unorganised effort.

In their relations to one another, institutions that profess a common public aim show a spirit of jealous competition more prominently than any community of ideal. One cannot study the recent history of university education in London without being painfully impressed with the fact that internal friction in a machine without design results in a consumption of energy that costs more than the educational output is worth.

Our scientific and technical societies similarly suffer from overlapping and conflicting interests, and this Conference will be of some value if, instead of discussing for once some special scientific problem, its members become inspired with a desire to direct the activities of the societies they represent, so as to reduce the quantity of machinery, to correlate their activities with those of the metropolitan institutions with headquarters in London, to subdivide those institutions composed of dissimilar elements, and to assist, so far as practicable, the regrouping of those who work with common data and with a common aim.

An excellent illustration exists of the way in which reform of this kind is possible when members are sufficiently public-spirited to distinguish between the wider interests of science and those of their own special societies. Up to 1889 there were in this country about eight separate societies devoted to the technical interests of coal mining. In that year four of these societies federated their interests, and during the few following years three others joined the federation, and pooled their resources to meet the cost of a common publication, and to maintain a common office at Newcastle.

In 1892 the Institution of Mining and Metallurgy was founded in London to meet the wants of technologists devoted mainly to the requirements of metalliferous mining. The rapid growth of this institution, its metropolitan location and its comprehensive name, challenged the premier position of the Federated Institution of Mining Engineers. The latter consequently changed its name to *The* Institution of Mining Engineers, and moved its central office to London. Thenceforward each institution, not only published papers on its own special branch of mining, but trespassed frequently on the natural domains of its competitor. Later, when one of these institutions applied for a Royal Charter, the other, in its own interests, successfully opposed the application.

But in 1913, through the happy possession of two Presidents who could distinguish parochial from national interests, both institutions agreed to a delimitation of their spheres of influence, and each supported with success the petition of the other for a Royal Charter. They are now no longer competitors, but sister institutions; and, instead of competing for recruits, they can afford to define and maintain a common standard of technical qualification and professional etiquette for the British mining engineer.

One of the first principles observed by a student of science is that of classification. Classification means not merely the bringing together of things that are similar in some essential feature; it also means the separation of those that are essentially unlike, although superficially bearing some form of resemblance.

One realises how hard it is to apply the pruning knife of scientific classification when one contemplates the spectacle of the various "literary and philosophical societies" which still survive, mostly under financial difficulties, in many of our large provincial cities, vainly endeavouring to cover "the whole realm of Nature." Such societies, embracing the general range of sciences, and sometimes even including literary subjects, exist at Aberdeen (founded in 1840), Birmingham (1858), Cambridge (1819), Edinburgh (1731), Glasgow (1802), Leeds (1820), Manchester (1781), and Newcastle (1793); while at Dublin, where individuality seems ever to flourish in various departments of civilised activity, there are two such societies, with apparently overlapping interests in general science: the Royal Dublin Society, founded in 1731, and the Royal Irish Academy, founded in 1785.

There are not many among these societies whose publications can be safely neglected by the research worker in any of the specialised branches of science, and yet most of them could not show an average annual output of one serious paper in each of the science subjects as defined by the twelve Sections of the British Association. They become in turn the fortunate victims of some local enthusiast, who in time passes away like a comet, or finds wider scope for his ambitions, either in the Royal Society of London, or in the metropolitan society that governs his own pet subject, where his products enjoy the benefit of more thorough discussion, and sometimes appreciation, by fellow experts. He removes his attentions from the gallery to tickle the fancy of the stalls.

If we take the Literary and Philosophical Society of this city, which has for many years devoted itself almost entirely to science, and issues memoirs which no serious worker can afford to overlook, we get an example of the way in which the student is taxed in his search for the "previous literature." Of ninety-one papers published in *The Manchester Memoirs* during the past five years, as many as thirty-four belong to a class that would be referred to Section A of this Association, this abundant enthusiasm being largely due to a local occurrence of radio-activity. Of the remainder, ten would come under Section B, seven—entirely palaeontological in character—come under Section C, twenty-two under Section D, two under Section H, two under Section I, thirteen under Section K, and one under Section M.

One can sympathise with those readers who grumble at one halfpennyworth of geological bread to this intolerable deal of physical and biological sack.

Now, it is important to remember that this Society is maintained by less than one hundred and fifty members, many of whom are members only through general interest in science, or merely in consequence of a commendable desire to keep alive an institution which has an honourable record. Thus the critical discussion of most papers presented must be confined to a very small number, and herein arises a danger that may at any time give rise to consequences far more serious than the burial of a paper with an overburden of unrelated literature; for the author of the paper himself must often be the only member capable of deciding as to whether his paper is or is not suitable for record as a definite addition to scientific data or thought.

To the outside student, therefore, the publication of a paper by such a small society gives no *prima facie* reason for regarding it as a serious and probably trustworthy addition to scientific literature. The papers so issued must be most embarrassingly unequal, and wholly indeterminate in character; yet no stranger can run the risk of disregarding such publications.

But the tax thus laid on students of scientific literature is not the only drawback or danger due to the activities of

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such small, local, non-specialised societies. They often possess collections of natural-history specimens, or of physical instruments for which they become, by mere possession, trustees to the whole scientific world. As in the case of published literature, the circumstance that these things are often unknown to the rest of the world, or are almost inaccessible to the student, is only one, and not the most serious, danger; for one knows instances of collections suffering from neglect, or, still worse, suffering from the activities of some member who temporarily dominates the governing body, and entertains strong views as to the cost of maintaining collections that, from his special point of view, are of no value.

Before proposing, in the name of Organisation, to abolish such unspecialised societies, or before hinting that they have outlived their times, or before even suggesting that they might now be allowed to die a natural and respectable death, one should exert one's ingenuity to devise some scheme for turning them to account. They inherit traditions in most cases that only an unregenerate iconoclast would despise; most of them were founded when science was barely specialised, and when facilities for attending London meetings were imperfect; many of them have published memoirs that are now of classical value, and they have included among their active members the most worthy names in the history of science; most of them possess libraries that could not now be purchased for money, although these are often neglected, and, for financial reasons, often difficult to use.

Even as monuments, therefore, societies such as those that I have mentioned deserve preservation. How, then, can one turn their resources to good account, and organise their culture without the drawbacks of *Kultur*?

The plan that has often occurred to me as a possible compromise between the claims of central organisation and of provincial autonomy is this. The recognised chief among such societies—the Royal Society of London—should, by affiliation of its provincial poor relations, take over the cost, as well as the responsibility, of their serious publications. They would enjoy home rule so far as their meetings, discussions, finances, and libraries are concerned; but the papers offered for publication would be censored, in the usual way, by the appropriate sectional committees of the Royal Society; and, if passed, would be published, either in the *Proceedings* and *Transactions* of the Royal or of some metropolitan specialised society. Such papers would then rank technically, not by mere courtesy, as "publications" for purposes of quotation or priority. The local interest in science would not then be curtailed, and the geographical handicap, especially of junior provincial workers, would be removed; while the provincial scientific communities would be able to maintain their treasured monuments, without, as now, a constant fear of financial difficulties, and without a recurring dread that senility in the respected old "lit. and phil." will soon end in the way of all things living.

So far as our local example is concerned, many if not most, of the papers which I have just classified by the British Association system might well have been accepted by the Royal Society; for the majority of the papers published in its *Proceedings* are also by non-members. The last six volumes of the *Proceedings of the Royal Society* contain papers by three hundred and eighty-four authors, of whom only one hundred and forty-one are Fellows of the Society.

I am quite aware of many difficulties in the way of this proposal: fears, on the one side, that the Council of the Royal Society will acquire a dangerous power of controlling the freedom of the scientific writer; and forebodings, on the other, that the duties of the Council threaten to become "heavy burdens and grievous to be borne"; while the cost of such additional publications will be removed from the local body to be thrust upon the Royal Society.

With regard to these objections, the circumstance that a young worker's paper has been hall-marked by the Royal Society will soon be regarded as fair compensation for what would, after all, be but partial loss of freedom; for the local societies, as well as the various journals, can still publish what they like, though the foreign student may not be blamed for neglecting any but technically published scientific literature.

The extra burdens added to the Council and Sectional Committees of the Royal Society are merely of a kind that someone *must* undertake, if we are to have any regard at all for the progress of science; and it will soon be necessary for the State to recognise the national value of the work done by the Council and Committees of the Royal Society in more ways than nominal recognition of their ornamental positions.

In practically every country on the Continent of Europe the premier learned academies, that occupy positions corresponding to the Royal Society of London, are financially supported by the State, and even the ordinary members are paid.

In this country scientific organisations, like the universities, are largely dependent on private charity, with the result that, while we get the benefits of individuality and local competition, we suffer, as the war has already proved to us, the necessary loss of power, due to an undesirable number of wheels in our machine, due to unnecessary duplication of effort, and due to industrial and financial eddies in the stream of progress; in a word, due to want of method and organisation. That is the theme which I wish the delegates present to take back for practical consideration by the societies that we represent.

It is important to remember that organisation necessarily requires someone to take the lead and someone to fill the subordinate's place, otherwise all is anarchy; and, whatever may be the discipline within each society, their relations to one another at present can but be described as anarchy. The Fellow of the Royal Society has no more responsibility at present than any member of the smallest debating club. His selection is regarded as an honour, but an honour is as meaningless as an iron cross, if it does not imply responsibility and an opportunity for more work. What applies to an individual applies to a society of such persons. The premier position of the Royal Society is acknowledged by every British worker in science, and those societies which similarly embrace all phases of science can assist the aims of organisation by reminding the Royal Society that its position is more than ornamental, and that its lead will be welcomed.

Dr. W. E. Hoyle then introduced the subject of "Local Museums," which had been chosen for discussion by the Corresponding Societies Committee at the suggestion of the Selborne Society.

LOCAL MUSEUMS.

The duty of the opener of a discussion, as I understand it, is not to present an exhaustive treatise on the subject entrusted to him, but merely to throw down, as it were, certain "bones of contention" which those present may worry to their hearts' content. I shall, therefore, with all possible brevity, place before you a few theses, and leave my audience to fill up the too obvious lacunae in my observations.

May I lay it down at the outset that the first and fundamental function of a museum is to preserve? We museum officials are nowadays given so much good advice about the desirability of making our exhibits aesthetically attractive, of compiling explanatory labels, which shall at the same time instruct the specialist and interest the casual visitor, and of catering for school children, that we are perhaps in danger of forgetting that our paramount duty is to see that "neither moth nor rust doth corrupt," and that "thieves do not break through nor steal." It always tends to clearness of thought in approaching any subject to begin with a definition. I will therefore provisionally define a "local

museum" as a museum existing in a place, belonging to that place, destined for the instruction and delight of the dwellers in that place, and illustrative of that place, and will leave to my critics the congenial task of picking holes in my definition.

It follows from this that the first duty of a local museum is to preserve the things of interest pertaining to the locality, whether they illustrate its history, folklore, natural history, or any other topic. These must be carefully kept, and every particular relating to them recorded with scrupulous accuracy. A certain proportion must be exhibited in such a way that their points of interest may be readily seen, and they must be adequately labelled—all this in accordance with principles which are nowadays well understood by every qualified museum official. Complete reference collections of animals, plants, fossils, and the like must be formed and kept in cabinets accessible to those desiring to make use of them for purposes of study.

Here, I think, it is necessary to consider the important and delicate question: What ought to be the relations between the local museum and the national museum? Broadly stated, the solution is to be found in the general principle, what is of national importance should be preserved in the national museum; what is of merely local interest should be kept in the local museum. Like many general principles, this is quite easy till we begin to apply it to particular cases. These require judgment and tact for their successful negotiation. May I give one single instance? In a remote part of the Celtic Fringe is a mass of sand dunes which cover what was once a city of sufficient importance to have a Royal Charter, a roll of burgesses, and a mace. In 1886 the corporation was dissolved: the burgesses, their sons and widows, were to receive the sum of eleven shillings per annum, and the mace was kept in a public-house, where it was produced for the inspection of any one who cared to pay for a drink in order to have a look at it. Such an arrangement had obvious dangers, and the national museum naturally wished to have possession of the mace. It was found that the burgesses had no power to give it, but they consented to deposit it in the museum provided a replica were furnished to be kept in the public-house. This was agreed to, and a replica, which is hardly distinguishable from the original, was provided, and I am informed by a recent visitor that the landlady continues to exhibit it as the original, so that all parties are satisfied.

It having been admitted that the formation and preservation of a local collection is the prime duty of a local museum, and supposing this function to be adequately discharged, should a local museum undertake any others? I should say, "Certainly, if its means and opportunities allow," and the possibilities are many and various. One obvious way in which the museum can be of the greatest service is by providing collections which shall give the visitor a preliminary sketch of some department of knowledge. I allude to what are often called "index" collections, though the term "introductory" collections would be more appropriate.

For instance, a larger or smaller collection, illustrating the animal kingdom, would furnish a suitable preliminary to a study of the local fauna; a series of specimens, showing the technique of different processes of engraving, etching, and mezzotint, would furnish a valuable introduction to a collection of local prints; a number of objects from different prehistoric and historic periods would enable the visitor to place in their proper chronological relation the collections of local archaeology; and numerous other possibilities will readily suggest themselves.

Another direction in which a local museum may profitably develop is by coming into direct connection with the educational system of the locality. This may be done either by setting apart and furnishing a room for the special use of school classes, or by providing topical collections, which can be lent to, or circulated among, the schools. There is already an extensive literature on this subject, so I need not enlarge further upon it, the more so as a committee of this Association is actively engaged in studying the educational uses of museums.

Furthermore, there is, to my mind, nothing out of place in a local museum developing a special subject, quite disconnected with the locality, if it has the power to do so without interfering with its proper work. Suppose, for example, that some well-to-do citizen has acquired an important collection, say, of seventeenth-century furniture or Japanese works of art, which he is desirous of giving or bequeathing to his native town.

There is no objection to the museum accepting such a gift and developing it to the best of its power. It will be a source of pride and delight to the inhabitants; and, if it is not so to begin with, may become a collection of real importance, which will attract specialists to visit and study it, greatly to the advantage of the museum and the town.

As instances of such collections may be mentioned the Gurney collection of raptorial birds in the Norwich Museum, and the Egyptian collections in the Manchester Museum.

I may, however, remark, by way of parenthesis, that the generous donor leaves his work half done, if he bequeaths a collection without also providing some means for its maintenance and development; and he is by no means a benefactor if he attaches to his gift embarrassing stipulations as to its being always exhibited in cases of a particular type, and excludes the possibility of its enlargement and development.

May I conclude in the words of a great teacher, applicable to local as to other museums?—"The first function of a museum is to give an example of perfect order and elegance. Everything should be in its own place, everything looking its best because it is *there*. Nothing should be crowded; nothing unnecessary. The museum is only for what is eternally right and well done.

"The least things are there and the greatest and all good.

"The simple may go there to learn and the wise to remember."

The discussion turned chiefly on the specimens which should be kept in national as opposed to local museums, and it was the opinion of some delegates that the use of museums for educational purposes might put too great a burden on the curators.

At a second meeting of the Conference mention was made of the interest which had been aroused by the suggestions contained in the President's address, and Mr. Whitaker, the Vice-President, read the following explanatory remarks:—

The existing practice prevents a suitable classification of papers, and affords no guarantee to research workers that the papers have been considered by any body observing a constant and recognised standard.

It is the opinion of many that the progress of science would be greatly facilitated by the adoption of a system such as that suggested by the President, namely, by a form of limited control by the Royal Society in the matter of publications, or by an independent federation of the non-specialised scientific societies. By either of these two systems it would be possible for original papers of scientific value to be made more accessible to research workers, as such papers would then be suitably grouped by subjects, and would appear in a recognised serial accessible in all important reference libraries.

With regard to the proposal to form an independent federation of non-specialised societies, there is the obvious objection that such an institution would add one more to an already embarrassingly large variety of papers.

After some discussion, the following resolution was passed: "That this Conference of delegates invites the attention of the Corresponding Societies Committee to the President's opening address, in which suggestions are made for reforming the existing varied and unorganised practice of publishing original papers."

(To be continued.)

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THE FLOWER TABLE AND ITS EDUCATIONAL VALUE.

By A. R. HORWOOD, F.L.S.

(With illustrations from photographs by A. Newton.)

ONE has been familiar for some time past with the exhibition of wild flowers in museums. Brighton, in England, was one of the first to take up the method then new, which first hailed, we believe, from Sydney, New South Wales.

The ordinary wild flower exhibit, as seen in museum and school alike, however, has been more or less confined to the arrangement of flowers according to some accepted plan, with no information except the Latin and English names in the first place. Later the habitat was given, with the status and frequency, and the natural order.

This method was all very well in days when botany, whether field botany or herbarium work, meant the mere identification of the plant alone, or the study of systematic botany.

Nowadays, however, field botany, or ecology, has taken such a hold upon those who love plants that the old plan is insufficient; and it has taken the shape of learning the how, the why, and the wherefore of the plant's habitat, or its habit and main characteristics.

Already also wild-flower tables have been inaugurated upon which the plants are arranged according to their habitat, or ecologically, *e.g.*, bog plants, heath plants, plants of the seashore. This is really not, as some have supposed, an aid to their identification, but it gives very practical hints to others besides the pure botanist as to the relation between the plant and its surroundings, or the plant's requirements in a word. The gardener, the horticulturist, or the dilettante person, with a hobby for a rock garden or an Alpine garden, can all learn much from such an arrangement, especially where details are given as to the altitude or the rock-soil, and when its constituents are given. This, indeed, is a feature which should never be overlooked in a museum where wild flowers are arranged; and I give this hint for what it is worth for those who organise flower shows and exhibitions to adopt. It should be a very profitable innovation; and, as in other matters, if the staff of a museum were asked, they would be quite ready and pleased to superintend and organise such an arrangement, even if, as is unlikely in every case, they were not experts in purely horticultural matters.

Realising, moreover, the widespread interest in garden plants and their convenient perennial flowering in many cases, as well as the primary advantage of their showy flowers, the Leicester Museum has improved upon an old custom in vogue some years ago of exhibiting horticultural material. Originally the collection consisted largely of palms and other exotic or temperate evergreens.

But the new departure consists of the exhibiting of common spring garden flowers of different groups, chosen for their popularity or beauty, to create an aesthetic appearance in a room otherwise composed (as in every museum perforce) of inanimate objects. However attractively these may be displayed, they lack the interest of living material. This exhibit of current life, in fact, helps to rejuvenate such an institution, and to lend added interest to the material.

Figure 271 shows a beginning in this direction, made when only a few wild plants were in bloom, such as arum, hazel, willows, elms in flower, ivy in fruit, gorse, winter aconite, coltsfoot, and so on. These are arranged, among others, on the top of the stand.

Below are vases or pots with the common arabis, or rock cress, sweet violets, almond in blossom, polyanthuses, scilla, snowdrop in a box showing the bulbous stem below, and butcher's broom. This gives a fresh and pleasing appearance to the flowers above, which, not being cultivated, are relatively inconspicuous, and not so beautiful. One feature of cultivated plants is their increased fertility, because their more conspicuous blooms make them more likely to meet with favour with the bees and other pollen- and honey-seeking insects.

The little glass-sided boxes, lined with zinc, show, in the case of arum, the thickened corm, which is, or was, used for sago in Portland. It shows, too, in the case of the coltsfoot, the subterranean stem, or stolon. A new departure here, again, lies in the utilisation of certain plants to describe and illustrate wide or interesting principles. Thus arum is used to illustrate the food-storage of bulbous and other plants; the trees illustrate wind-pollination, and later wind-dispersal. Gorse illustrates how plants protect themselves, and coltsfoot is used to explain the nature of a composite flower.

Figures 272 and 273 help to show the evolution of this beginning into two definite sections: the wild-flower exhibit, with only wild flowers, and the early spring garden flower exhibit (see Figure 273).

In Figure 272 a still further novelty is introduced. The bottom row of plants consists of cryptogams, arranged in vases, glass dishes, tanks, or, in the case of the polypody fern, in glass-sided

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FIGURE 271.

A Wild Flower Exhibit in Leicester Museum in March, made up of wild flowers on the top tier and garden flowers below.

FIGURE 272.

A Wild Flower Table in Leicester Museum, showing wild flowers above and cryptogams below.

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FIGURE 273.

A Stand at Leicester Museum of early common and garden flowers.

From a photograph *by Messrs. Lascelles & Co.*

FIGURE 274.

Catalpa Tree at The Hermitage, Hanwell.

(By the courtesy of the Editor of *The Selborne Magazine*.)

boxes. Here are tree and ground lichens, tree, ground, and aquatic mosses, hepatics that love moist banks, and ferns. This method does not seem to have been attempted elsewhere before; but, in view of the increased interest now taken in these lower plants, it is a novelty of growing importance, and has been greatly appreciated. Above are flowering plants arranged much as before.

Figure 273 shows a choice collection of spring garden flowers, consisting of those previously mentioned, and hellebore, hyacinth, tulip, narcissus, crocus, double daisy, grape hyacinth, and so on. Altogether the blaze of colour and the general effect of this table are very pleasing, and we commend this new method of popularising botany and a love of flowers to all who live in town and country alike.

THE SELBORNE MAGAZINE.

THE current number of *The Selborne Magazine* contains an interesting article by Mr. Hugh Boyd Watt, in which he deals with catalpa trees, more particularly those growing in London, and the largest specimens known in this country. He says :—

"The reputed oldest catalpa in London (which Mr. H. J. Elwes states died a few years ago) was one in Gray's Inn Gardens, often miscalled 'Bacon's tree,' the tradition being that Sir Walter Raleigh brought it from Virginia, and Sir Francis Bacon planted it. This is erroneous, as the species was not introduced into England until the year 1726. In 1808 there is an observation in *The Botanical Magazine* that 'the largest specimen we have ever seen grows in the garden belonging to the Society of Gray's Inn'; so this tree seems to have lived for well over one hundred years. There are two old trees in the garden at present, one of them said to be grown from a cutting from the original tree, and both are carefully looked after, and banked up and supported where necessary. They have heavy branches, descending to the ground at their outstretch, and bear thick foliage, but they have not flowered in recent years.

"The scientific name of the trees referred to is *Catalpa bignonioides* Walt., a native of the Southern United States of America. Another name, 'the Indian Bean,' is due to the conspicuous character of the fruit, which forms a cylindrical pod, like a piece of green or brown cane, growing to the length of twelve or fourteen inches, and hanging in loose clusters from the branches. This fruit remains on during the winter and spring, and is an eye-arresting object. Another distinctive external feature is the frayed and fibrous appearance of the bark, chocolate brown in colour, on the bole, even in young trees.

"The chief attraction of the catalpa is its flowers (see Figure 274), which consist of large erect panicles or trusses of bloom, borne at the end of the branches. The individual flowers are bell-shaped, with an elongated lower lip, and are white in colour, sometimes with a violet tinge, and marked inside with yellow and purple. As a contrast and set-off to this lovely blossom are the large, heart-shaped leaves of a soft, light green colour. At a distance a catalpa in flower bears a superficial resemblance to a horse-chestnut. The flowering period is from mid-July to mid-August, but I have seen the blossom by July 10th; and, on other trees in another year, as late as September 14th. A forest-tree flowering abundantly and beautifully, so much later in the season than our native trees, is indeed well worth cultivating, and deserves to be better known and more planted, particularly as it takes kindly to town life."

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

THE GAZETTE ASTRONOMIQUE of the Antwerp Society is now published in London, where the Editor, M. Felix De Roy, is residing. No. 83 contains much interesting matter. F. Henroteau has an article on an active but short-lived group of spots, almost exactly on the Sun's equator, in June last. It showed continuous change, apparently indicating that the equator is an unstable region for solar outbursts. The equatorial position generally occurs at the end of an expiring cycle, but this spot appeared early in the new cycle. An article on "The War and Scientists" notes with satisfaction that the manifesto of German men of science early in the war was signed by only one astronomer, Professor W. Förster, who is very old. Even he seems to have subsequently receded from the attitude expressed in the manifesto, since he expressed his satisfaction that the international work on the variation of latitude had not been stopped by the war.

Mr. W. F. Denning has an article on "The Real Paths of two May Aquarid Meteors," observed in duplicate by Mrs. Fiammetta Wilson and M. F. De Roy.

The first meteor was seen 1915, May 3d 3h 1m a.m. It moved from a point forty-eight miles high, seven miles south-west of Sevenoaks, to a point forty miles high, four miles west of Reigate. Speed, thirty-seven miles per second; magnitude, 2½; radiant, 335°—2°. The second meteor was seen May 6d 2h 52m a.m. It moved from a point sixty-nine miles high, six miles west of Tonbridge, to a point fifty-nine miles high, fourteen miles east of Swindon. Speed, forty miles per second; magnitude = Jupiter; radiant, 339°—2°. Half an hour after this last Mrs. Wilson observed another splendid Aquarid, but it was not seen in duplicate. The special interest of these meteors lies in the very high probability of their association with Halley's Comet. These particular meteors have been very widely separated from the parent comet, which is now between the orbits of Saturn and Uranus. It would seem likely that we must push back the birth of Halley's Comet (or perhaps we should say its introduction into its present orbit) considerably further than the two thousand one hundred and fifty years through which its history has been traced by a comparison of theory with the Chinese and other records.

The speed of the meteors cannot be very accurately deduced from two observations only, but the above speeds are in good accord with theory, and indicate the high quality of the observations. There are surely many more observers who might take part in careful meteoric observation. No instrumental equipment is required beyond a good star map, a binocular (not essential), and means of determining time to the nearest minute. It is perhaps the most obvious field in which useful work can be done with practically no equipment.

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THE ROTATION PERIOD OF MARS.—I have received a letter from Professor W. H. Pickering on this question. It will be remembered that Professor Lowell lately announced the value 24h 37m 22·57s, which is 0·08s less than the previously accepted value. Professor Pickering insists on the importance of using micrometer measures of markings on the disc, and rejecting for this purpose drawings of the whole disc. He also advises using several different points of reference, as he considers that many markings on the planet's surface are liable to change their shape and position. In particular the double marking, Fastigium Aryn (formerly Dawes' Forked Bay), that has been adopted as the prime meridian, was either invisible or extremely faint at the last apparition, and he suspected that its position was altered. Possessors of large instruments frequently use them merely for drawing the disc. They will do most useful work by carefully timed micrometer measures of the distances of various easily identifiable markings from the east and west limbs.

Professor Pickering also alluded to his lunar work, and particularly to his opinion that certain regions are subject to outbursts of vapour under the influence of the Sun's heat. I had suggested the difficulty of reconciling the presence of vapour with the extreme rarity of the lunar atmosphere. He replies by drawing attention to the parallel case of Mars. Some mathematicians have deduced that snow cannot melt on Mars. "Nevertheless, we have seen it do so for the last hundred years." He considers that the lunar day (twenty-nine and a half of our days) is to be looked on as the seasonal year of the Moon, for the inclination of the lunar axis to the plane of her orbit round the Sun is only $1\frac{1}{2}°$, which is too trifling to produce any marked seasonal effects in three hundred and sixty-five of our days. On the other hand, the change of temperature in twenty-nine and a half days is immense, especially since the very rare atmosphere offers no obstacle to the radiation of heat into space. Hence we must look on sunrise at any point as the local spring; noon as the local midsummer; sunset as the local autumn; night as the local winter. He continues: "At sunrise, their spring, we see certain brilliant white areas on the Moon. As summer comes on they diminish in size, and break up into smaller pieces, and in some cases disappear. Towards sunset, their autumn, they again increase in size. If it is snow on Mars, I believe it is snow on the Moon. The vapour might be projected from the interior, or even sustained by electrical repulsion."

It may be said, in reply, that the snow-melting on the Moon is a much less obvious phenomenon than that on Mars, where it could not be missed, even with a three-inch telescope. Some have considered that the apparent darkening of some lunar regions, as the Sun rises higher, may be merely a contrast effect, due to their brightening less rapidly than neighbouring regions. It is a case, however, in which those only have a right to be heard who have made equally sustained and careful study of particular regions on the Moon as Professor Pickering himself.

MR. MELOTTE'S CATALOGUE OF STAR-CLUSTERS.—This catalogue appears in *The Memoirs of the Royal Astronomical Society*. It has been derived from an examination of the photographs of the entire heavens taken by Mr. Franklin Adams with a portrait lens. It may therefore claim greater homogeneity than previous catalogues, since the whole material has been derived by the same person on a uniform system. He divides the clusters into four classes: (I) Well-defined globular clusters, with central condensation; (II) loose clusters, with well-defined outline; (III) loose clusters, with irregular outline; (IV) coarse large clusters, including the Pleiades, Hyades, and the cluster in Coma Berenices. This last is singular in being near the galactic pole (galactic latitude 85°); the great majority are within 30° of the galactic plane. This concentration towards the galaxy shows that they are very remote from us. There is the further remarkable fact that nearly all the Class I clusters are in one hemisphere of the sky, whose centre is in R.A. 16h 30m, S. Dec. 58°. We might infer this direction to be that of the centre of the stellar system, since we look through a deeper stratum of stars in the direction of the centre. However, some more reliable methods of fixing the direction of the centre indicate the constellation Gemini, which is quite different from that suggested by the clusters.

The catalogue contains two hundred and forty-five objects, of which eighty-two are in Class I and fourteen in Class IV. Of those in Class I, forty-seven are under 5′ in diameter, twenty-two between 5′ and 10′, and eleven between 10′ and 20′. Sixty-six objects noted as clusters by other observers are rejected in this catalogue, some because they are nebulae, others because they are too loose and ill defined to justify their inclusion. Several objects in the Magellanic clouds are thus rejected, but one globular cluster has been retained in these regions. It is conjectured that its connection with the cloud may be merely optical.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

INFLUENCE OF LIGHT ON RESPIRATION.—An interesting example of the manner in which discoveries in one branch of science may afford a clue to the unravelling of problems in another, which is, at first sight, very distantly related, is given in a recent paper by Spoehr (*Bot. Gaz.*, Vol. LIX). It has been known for some time that respiration, both in animals and plants, as indicated by the rate of liberation of carbon dioxide, is increased by exposure to light, other conditions being kept uniform; and more recently it has been found that respiratory activity is higher during the daytime than during the night in the case of plants kept at constant temperature and in total darkness—that is, when the only variable external condition to which the plants are exposed is the *air* of daytime on the one hand, and that of the night on the other. Spoehr has made careful determinations of the day-night ratio of respiration with normal and deionised air, and his results indicate that, as might be expected, there is a definite relation between respiratory activity and the ionisation of the air due to sunlight. The accelerating influence of light and heat on oxidation processes in plants may therefore probably be explained by the necessity for the dissociation of free valencies in the oxygen molecule; that is, it is apparently the partially dissociated oxygen that combines with the oxidisable substances in such processes.

PLEODORINA ILLINOIENSIS IN BRITAIN.—Grove (*New Phytol.*, Vol. XIV) records the discovery, in Britain, of the remarkable and interesting freshwater alga, *Pleodorina illinoiensis*, a member of the family Volvocaceae, which, until recently, was known only from the United States, but was later found in a few localities in Western and Central Europe. From Grove's observations, it would appear likely that *Pleodorina* is merely a variety, or a special state, of the well-known allied genus, *Eudorina*. The distinctive character of *Pleodorina* is the presence, at the anterior end of the body, of a number of cells, which differ from all the rest of the colony in being smaller, and in being purely vegetative, *i.e.*, not giving rise to reproductive cells by division. Grove finds, however, that this distinction is not absolute, but that the so-called vegetative cells can and do divide, though less frequently and at a later stage than the others. He gives also interesting notes on *Eudorina*, and his paper should be consulted by those interested in freshwater algae, since it would appear likely that *Pleodorina* is of much wider distribution than has hitherto been supposed.

A *SPHAGNUM* BOG IN THE TROPICS.—Although usually associated with cold, temperate, and arctic regions,

Sphagnum bogs are found in the tropics on the highest mountains. Gates (*Journal of Ecology*, Vol. III) gives a detailed and interesting account of the vegetation of a bog of this kind, found on Mount San Cristobal, near Manila, Philippine Islands. The mountain is an extinct volcano, and between four of the highest peaks (about five thousand feet high) he found a large shallow basin, parts of which are waterlogged all the year round, and thus present the conditions necessary for the development of the peat-moss. The successions exhibited between the plant associations are closely analogous with those observed in temperate regions, so far as the general habit and mode of growth of the plants are concerned, though, of course, the species concerned are very different. The peat-moss itself does not flourish so well in competition with the other plants, as it does in northern bogs, for the absence of a simultaneous period of rest for all the plants gives the higher types greater opportunity to succeed each other at a faster rate, correspondingly increasing the difficulties of maintenance among the lower associations; so that, although the *Sphagnum* is found spreading out from the lakes, it is only by an upward change of water level that it can do so much as hold its own as a distinct association. Hence the peat-moss is, for the greater part, limited in distribution to the margins of the water, especially where it is not shaded by grass or bushes, though in some places it succeeds in building mats out into the lake as in northern bogs.

PLANT CONSTITUENTS OF COAL.—In an interesting discussion of the composition and qualities of coal, Jeffrey (*Econ. Geol.*, Vol. IX) claims, by improved methods of making thin coal sections, to have obtained new and valuable results in the study of its composition and mode of formation. He believes that both of the suggested methods of accumulation—that resulting from the heaping up of remains of successive generations of plants in peat bogs (autochthonous origin), and that resulting from drift in lakes or lagoons (allochthonous origin)—commonly take place in the temperate regions, but that only the method of accumulation by drift takes place in the tropics, nothing corresponding to a peat bog of the temperate climates having been found in the tropics. From microscopic examination of coal, he concludes that the allochthonous theory also harmonises best with the structure of coal, and his conclusions support the view that the climate of the coal-forming periods approached present tropical conditions. The canneloid coals (*e.g.*, the true cannel coals, tasmanite and boghead coals) are composed chiefly of spores, embedded together with some woody material in a dark-ground substance. Many of these bodies had been considered as algae, but, owing to improved methods, can now be identified as spores—much crinkled and collapsed. These coals have been formed under open water, representing the mud of ancient lakes or lagoons. The ordinary bituminous coals are composed of both woody, or lignitoid, material, and spore, or canneloid, material in varying proportions. The woody constituent is found in layers, and has lost completely its original organisation, a condition generally observed in coals derived from vegetable débris. Carbonised wood or charcoal is the only material derived from the grosser parts of plant bodies which retain structure in coal. Between the shiny lignitoid layers are lodged the duller canneloid layers, containing the remains of flattened spores in the dark-ground mass. Coals, therefore, may be composed of three recognisable constituents, spores (canneloid), modified wood (lignitoid), and, less commonly, relatively unmodified carbonised wood or charcoal. The properties of coal depend largely upon the proportions of the original constituents. Coals rich in spores, such as cannels, bogheads, and oil shales, are highly bituminous, and in some form or other are the mother substance of oil and gas. The spore contents of a coal determine the fatness, and probably have a definite relation to its coking properties; while the lignitoid constituent reduces the bituminosity and coking value of coal.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

METALS USED IN SHELL MANUFACTURE.—*The Mining and Engineering World* (1915, XLIII, 146) gives some remarkable facts concerning the amounts of various metals required to meet the orders for shrapnel and other shells placed in the United States by European countries. It is stated that a British 3·3-in. shrapnel shell requires 5-lb. 9⅛-oz. of brass, containing about 66 to 70 per cent. of copper, or nearly 3¾-lb.; while round the shell is a small copper band, weighing 4¾-oz. For a shell of this size 1·87-lb. of spelter is required, and the contents of the shell consist of 7·92-lb. of lead bullets, composed of seven parts of lead and one part of antimony. It is estimated that the European orders for shells of all kinds are not less than 25,000,000, and that these would require 101,000,000-lb. of copper, 46,750,000-lb. of spelter, and 173,250,000-lb. of lead.

Rifle cartridges consist chiefly of copper, about a pound of the metal being used in the manufacture of the Lebel cartridges of the French Army. A small amount of spelter and of nickel is also used in these cartridges.

A finished 3·3-in. shell contains 6-lb. 15¼-oz. of steel, but the proportion of steel used varies considerably in other types of shells.

COMPOSITION OF BANANA MEAL.—A recent issue of *The Bull. Imp. Inst.* (1915, XIII, 200) gives the following analysis of a sample of banana meal from Jamaica: Moisture, 12·0; crude protein, 4·6; fat, 0·6; ash, 2·5; fibre, 0·7; and starch, and so on, 79·6 per cent. The nutrient ratio was 1 : 17·6, and the food units 93. About fifty per cent. of the crude protein consisted of nitrogenous compounds, probably amides, inferior in food value to true proteins. The general conclusion drawn from the analysis is that, although banana flour might be used locally as a partial substitute for wheat or maize flours, it is distinctly inferior to either as a food.

POTASH FROM KELP.—The scarcity of potassium salts, which has been one of the principal effects of the stoppage of German imports, has led to attempts to supply the deficiency from other sources. One of the most promising of these is kelp, large supplies of which could be utilised for the purpose. In a recent *United States Commerce Report* (No. 143, June 19th, 1915), Mr. F. K. Cameron gives the results of an examination of the various kelps found on the sea coasts of the United States. Of the various kinds analysed *Macrocystis pyrifera* contained, on the average, 12·59 per cent. of potassium oxide, 1·57 per cent. of nitrogen, and 0·23 per cent. of iodine. *Nereocystis luetkeana* contained 20·1 per cent. of potassium oxide, 1·9 per cent. of nitrogen, and 0·13 per cent. of iodine; while *Alaria fistulosa* contained 9·1 per cent. of potassium oxide, 2·6 per cent. of nitrogen, and a trace of iodine.

It is estimated that the available kelp area on the Pacific coast is 390 square miles, and that it would yield an annual harvest of 59,105,500 tons of fresh kelp, corresponding to about 2,266,000 tons of potassium chloride. Hence it would be possible to obtain from this source five times as much potassium salts as was previously imported into the United States from Germany. The total cost for cutting, drying, and storing the kelp is estimated at 3·83 dollars, while the total value of the product as a fertiliser is estimated at 15·75 dollars per ton, of which nine dollars would represent the value of the potassium salts.

It is further suggested that it might be found practicable to replace the seaweeds in some of the beds by varieties richer in potassium salts, such as, for example, egg kelp (*Pelagophycus porra*), which occurs in isolated patches along the coast of Lower California.

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BORON TRICHLORIDE.—The preparation and properties of pure boron trichloride are described by Messrs. Stock and Priess in a paper abstracted from the *Ber. d. d. Chem. Ges.* (*Journ. Chem. Soc.*, 1915, CVIII, 339). Moissan's boron was treated with chlorine in a glass tube at a temperature regulated to prevent, as far as possible, the glass being attacked. The resulting impure product was condensed at —80° C., and shaken with mercury and fractionally distilled in a vacuum at —78° C. to remove traces of hydrochloric acid and silicon chloride. The middle fractions of pure boron trichloride melted at —107° C. and boiled at 13° C. They did not attack hot mercury or combine with chlorine even at — 80° C. ; but the vapours reacted with fats, and it was therefore necessary to exclude all traces of grease from the taps of the apparatus.

GEOGRAPHY.

By ALEXANDER SCOTT, M.A., B.Sc.

THE IMPORTANCE OF GEOGRAPHICAL RESEARCH.—In the Presidential address to Section E (Geography) of the British Association at Manchester, Major Lyons discussed the various types of geographical investigation, and indicated those lines along which progress may be expected in the future. The prevalent idea that exploration represents the main field of research is erroneous, as much valuable work can be done even within the limits of the British Isles. The great quantity of information furnished by travellers often proves of little use, so far as scientific geography is concerned, owing to a lack of adequate training on the part of the observer. Mathematical geography constitutes a field which has been somewhat neglected in this country. With the exception of the work of such bodies as the Ordnance Survey, many of the geodetic and survey results are only approximate, while the degree of approximation is generally unknown. A technical description of the instruments used is necessary for a determination of the accuracy of the observations ; while it is also necessary to examine the methods of computation in order to appraise the value of the results. The methods of cartography, the compilation and reduction of maps, likewise offer a wide field for research. The processes involved are not merely mechanical, as they demand a knowledge of the region, as well as a critical analysis of the material from which the maps are being compiled. As before, the chief point lies in the relative accuracy of the data. The fact that mathematical geography requires a specialised training is probably responsible for the small amount of work done in this branch of the subject. Thus, although we have several books on map projections, a really comprehensive one, in English, would be useful.

When we come to physical geography, we find much more scope for research of a less specialised nature. For example, in the study of rivers, much valuable information can be obtained concerning load, evaporation, discharge, rate of erosion, the nature of the dissolved and suspended material, with but little apparatus. The same applies to lakes, where the excellent bathymetrical surveys, by Murray and Pullar, would serve as examples of how such work may be carried out. The method of classifying land-forms requires further and more systematic investigation, while a more exact and scientific nomenclature is also necessary. So far, geography cannot compare with the physical sciences with respect to exactness, but this may be partly due to the looseness of the terminology. It is essential that geographical terms should have definite and restricted meanings, as, the more truly technical the terms, the greater the claim of geography to rank as a science.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

GEOLOGY AT THE BRITISH ASSOCIATION : PRESIDENTIAL ADDRESS.—The President of Section C in the Manchester meeting of the British Association, Professor G. A. J. Cole, devoted an interesting address to a discussion of some of the larger aspects of geological science. He first called attention to the fact that earth history discloses large variations in the relative proportions of Continental and oceanic areas. As regards the foundations of the earth's crust, all modern research tends to the conclusion that the oldest visible rocks are sedimentary in character, although now, however, largely metamorphosed to schists and gneisses. The crust has been undermined and broken down, especially in Lower Pre-Cambrian times, by a process of sub-crustal fusion, by which the generally basic materials of the underside of the crust have been worked up, partly dissolved, or entirely assimilated, in vast, invading, granitic magmas emanating from below. The intense folding often seen in the invaded rocks is probably aided by the softening of their constituents under the heat of the magma. Professor Cole says : " The extensive metamorphism of the Pre-Cambrian strata, which amounts to a distinctive feature, must . . . be attributed, not to special intensity of tangential pressures in early times, but to frequency of igneous attack."

The main part of the address was, however, devoted to the thesis that certain crustal changes are comparatively rapid, and possibly catastrophic in character. The later mountain-building paroxysms of the crust have been at least as intense and extensive as those of Pre-Cambrian times, and are accompanied by the same order of igneous activity. During a period of great orogenic activity it is difficult to believe that phenomena of a catastrophic nature have not taken place at the surface of the earth. Professor Cole believes that human experience has been all too brief, despite its records of great volcanoes and earthquakes, to conceive of the vaster catastrophes which have involved the surface of the earth in the past, and possibly may affect it in the future. The uprising of crustal folds may have been so rapid as to produce great landslides, and vastly increased denudation effects on the margins of the raised areas. Thus gravitation alone may be a potent cause of the surface crumpling of the strata. The slow continuity of earth movements may also have been broken in regions of subsidence. The uplift of the Pacific coast of South America included rapid stages, as recognised by Darwin ; and we have also a recent example in the Yakutat Bay region of Alaska, where earthquake movements caused rapid uplift, amounting, in some cases, to forty-seven feet (see " KNOWLEDGE," June, 1912, page **434**). May not the downward movements of the adjacent sea-floors also have given rise to crustal collapses of a catastrophic nature ?

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.Met.Soc.

THE WEATHER OF OCTOBER.—October is frequently stormy and wet. The decrease of temperature is considerable, being more than six degrees less than September ; nevertheless, the month is often warm, considering the shortness of the days, thus compensating for the cold of the longer days in April and May. It was a warm month in the years 1847, 1857, 1861, 1876, 1886, 1898, and 1906. It was a cold month in the years 1842, 1880, 1881, 1885, 1887, 1888, 1892, and 1905. The chief feature in the month of October is the great rainfall, which exceeds that of any other month. On rare occasions snow falls to a considerable depth.

The mean temperature at Greenwich for October is 50°·0 ; in 1861 it was as high as 55°·2, while in 1887 it was as low as 45°·2. The average maximum temperature is 57°·5 : the highest mean was 64°·1 in 1861, and the lowest 52°·4 in 1881 and 1905. The average minimum temperature is 43°·2 ; the highest mean was 48°·4 in 1898, and the lowest 37°·7 in 1888. The absolute highest temperature was 81°·0 on the 4th in 1859, and the absolute lowest 24°·7 on the 28th in 1890.

The average rainfall for October is 2·72-in. ; the greatest amount was 7·65-in. in 1880, and the least 0·47-in. in 1834.

The heaviest fall in one day was 1·38-in. on the 15th in 1844. The average number of "rain days" (*i.e.*, days on which 0·01-in. fell) is 15·1; the greatest number of days was twenty-seven in 1853, and the least four in 1842.

The average amount of bright sunshine at the Kew Observatory, Richmond, is ninety-two hours, or twenty-eight per cent. of the possible duration.

The average barometric pressure in London for October is 29·910-in.; the highest mean was 30·269-in. in 1830, and the lowest mean was 29·573-in. in 1812.

TOTLAND BAY METEOROLOGY.—Mr. John Dover has for the last fifteen years published a booklet giving the results of his meteorological observations for the previous year at Totland Bay, Isle of Wight. Totland is bounded on the east and north-east by the parish of Freshwater; all the other sides are washed by the waters of the Solent or the English Channel. The sea consequently has a moderating influence on the temperature of the air. The sea is at its coldest about the middle of February, when its temperature is 42°·4, and it reaches its warmest point about the middle of August, when its temperature is up to 64°.

Mr. Dover, in his report for 1914, gives not only the results for that year, but also some interesting tables and details respecting the extremes and averages for preceding years, as well as the average of each day of the past twenty-eight years—maximum, minimum, and mean temperatures. The principal results for 1914 were :—

	Temperature.		Rainfall.		Sunshine.
1914.	Mean Max. °	Mean Min. °	Total in.	No. of days.	hours.
Jan.	42·2	35·0	0·45	11	59·7
Feb.	48·6	41·4	3·84	18	89·1
Mar.	49·6	40·6	5·45	19	107·2
April	57·9	42·7	1·00	10	234·6
May	59·6	46·0	0·62	8	216·2
June	66·1	51·3	0·84	6	274·5
July	65·9	55·8	3·44	15	212·0
Aug.	68·4	56·6	2·08	12	229·5
Sept.	64·7	52·2	1·27	7	205·5
Oct.	58·2	47·0	3·78	14	102·7
Nov.	51·4	42·7	4·62	22	89·3
Dec.	48·9	40·6	9·07	22	61·7
Year ...	56·8	46·0	36·46	164	1882·0

The highest temperature registered since the observations were commenced in October, 1886, was 86°·6 on August 13th, 1911, and the lowest 14°·0 on January 5th and 6th, 1894. The longest period without rain was from March 16th to April 29th, 1893.

THE WET WINTER OF 1914–15.—The abnormal rainfall and temperature of the four months, November, 1914, to February, 1915, gave to the past winter a character of unusual wetness and warmth over a large part of the British Isles. The period of four wet months was sharply cut off from the previous summer by a dry September and a very dry October, and is equally clearly separated from the coming summer by an exceptionally dry March and a dry April. Dr. H. R. Mill and Mr. H. E. Carter, of the British Rainfall Organisation, in a paper on this subject which they read before the Royal Meteorological Society, dealt fully with the abnormal rainfall of the four months in question, and showed that the general rainfall for England and Wales for this period was 20·21 inches. South of the Thames the fall exceeded twenty inches nearly everywhere, and there were areas in the south-eastern counties above twenty-five inches. The greater part of Devon and Cornwall had more than twenty-five inches, and on the wettest part of Dartmoor more than fifty inches fell. A striking feature of the comparison with the average for England and Wales is that the area with less than twelve inches of rain was barely one-tenth part of the area on the average map, while the area with more than thirty inches was nearly seven times as great as on the average map. December was by far the wettest month, the general rainfall being two hundred and eleven per cent. of the average; in November it was one hundred and thirty-four per cent., in January one hundred and forty-three per cent., and in February one hundred and ninety-eight per cent. of the average. The persistent nature of the rainfall caused extensive floods over practically all the low-lying parts of the country. The wettest previous winters were those of 1876–77 and 1911–12; that of 1914–15 was shown to be wetter than either of them.

RAINFALL AND THE GROWTH OF TREES.—The exceptionally heavy rainfall of last winter, followed by the good rains in May and July, has caused an immense growth in large trees, as well as in shrubs. A correspondent writes: "It is extraordinary how much the trees have grown out this season. It is very noticeable in roads, and where they stand near houses. The gardener reports the same additional speed of growth in shrubs."

PHENOLOGICAL OBSERVATIONS IN 1914.—The Royal Meteorological Society has for many years collected phenological returns from observers in all parts of the British Isles. The report on the observations from December, 1913, to November, 1914, has been prepared by Mr. J. E. Clark, and is based on the returns from one hundred and thirty-three stations. He shows that the outstanding features for 1914 were the mildness before and after January until May, the serious May frosts, and warm autumn; also the heavy rains of February, March, and November, with a dry period between, beginning and closing with widespread droughts. Taking the year for the whole British Isles, not a single migrant record was later than the mean, though the nightingale was neither early nor late, and the other migrants not specially early. The insect dates ranged from three days early for the honey-bee to ten days for the meadow brown butterfly, and twelve days for the wasp. Every one of the thirteen standard plants was again early; the five shrubs ranged from five days early for the hazel to nine days for the blackthorn and hawthorn, and ten days for the horse chestnut. The eight herbs began with eleven days early for the coltsfoot, and the next three were four or five days early, but the July flowers and ivy were a full week early. The mean date for the plant records was a week earlier than the average, compared with two days only in 1913.

MICROSCOPY.

By F.R.M.S.

FERNS AS MICROSCOPIC OBJECTS.—Although perhaps not of such scientific interest as many things described in these columns, there are few objects which will repay careful study better than the fructification of Ferns; indeed, no more pleasing low-power object can be shown than an uncovered fertile pinnule—say of *Todea hymenophylloides*—when seen through a binocular microscope with a good transmitted light, and on a faintly illuminated and suitable background, such as may easily be obtained by placing a piece of coloured gelatine upon the stage. Nor need we go abroad for attractive specimens, for our common Spleenwort, so shown, will furnish as pretty an object as can be desired; whilst, if a high-power be employed, a study of the different kinds of spores will afford employment to the amateur for many an evening to come. Inasmuch, however, as Ferns are chiefly classed according to the arrangement of their spore cases, no thorough knowledge of them can be obtained without the aid of magnifying power. Briefly, these spore cases, or thecae, found on the under side of the frond, are elevated on stalks, which are prolonged and widened near the top, and curling over there nearly form a ribbed ring, both sides of which are closed by a thin

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membrane, thus forming a receptacle in which the spores are matured. When ripe the dry ring becomes elastic, and exerts a tension which ruptures the membrane, and allows the spores to escape. The thecae are very numerous, a cluster of them being called a "sorus." In *Polypodium* these sori are grouped in circular uncovered patches, but in *Asplenium* they are arranged in lines, and in their early stages are covered with a delicate membrane, termed an "indusium." Linear indusia are also well seen in the common Hart's Tongue Fern, in which they arise from the venules, and cover the two lines of sori beneath their overlapping edges. In *Lastrea*, of which the abundant Buckler Fern is a good example, the indusium is kidney-shaped, and in its early stages is closed over the thecae. In *Aspidium* and *Polystichum* the indusium is circular, growing from the centre, and spreading over the sori like an umbrella. In *Cystopteris* it is hood-shaped, but in *Ceterach*, of which we have but one British species, growing freely in limestone districts, the sori, especially in young specimens, are densely covered with brown scales, which are themselves interesting objects for the microscope. In *Pteris* and *Adiantum* the edge of the pinnule is reflexed so as to form a kind of indusium. Amongst foreign Ferns, in *Cyathea*, *Hemitelea*, and *Sitolobium*, the indusia are cup-shaped, and the thecae grow round a central stem; but in *Notholema* and *Grammitis* they are covered with beautiful scales, which are well worthy of attention. In *Woodsia orientalis* the sori are long and narrow, lying along each side of the midrib of the pinnule, and entirely covered by indusia in their early stages. In *Lygodium* and *Davallia* the sori are at the ends of the pinnules, and are covered by indusiate capsules. *Oleandra* has a semicircular indusium; whilst the *Todeas* and *Dicksonia* have remarkable bivalve indusia, which are very fine objects under the binocular. It is advisable to examine Ferns in their early as well as their mature growth, as in the later stage the indusium, pushed aside by the growing thecae beneath, frequently splits open, and in some cases disappears altogether. Under a quarter-inch objective the various patterns formed by the markings on the spores of different kinds of Ferns can be well seen.

R. T. L.

PROTOPLASMIC MOVEMENTS.—Most microscopists are familiar with these movements in certain plants, notably in *Chara*, *Nitella*, *Vallisneria*, *Tradescantia*, and a few others. So far as I am aware, there are only about a dozen plants mentioned in books relating to microscopy which exhibit this interesting phenomenon.

A few weeks ago a friend called my attention to the white hairs on the inner surface of the corolla of the flowers of *Symphyandra Hoffmanni*, which is a member of a genus of the order Campanulaceae. I examined these hairs under the microscope, and, much to my delight, I was able to see the streaming of the protoplasm in them. There appear to be several kinds of hairs: some long and straight, and tapering to a point; others short, thick, and curved; and others of intermediate forms. It was in the first-named that I saw the movement referred to, and there was a very distinct current seen running along in opposite directions on either side of the hair, which was easily seen under a one-sixth-inch objective.

I exhibited this object at the Quekett Club on August 8th, and did not come across any members of the Club who were acquainted with it. Since then my friend has given me some flowers of a small blue Campanula—the name of which I do not know—and I saw the same movement in long, straight, tapering hairs, similar to those of the *Symphyandra*, from the inside of the corolla. It seems, therefore, that the order Campanulaceae may furnish interesting examples of protoplasmic movements. I only examined the specimens casually, not having had the opportunity of doing so critically; but what I have seen I consider worthy of the attention of microscopists.

THOS. N. COX.

PHOTOGRAPHY.

By EDGAR SENIOR.

LONG- VERSUS SHORT-FOCUS LENSES.—The desire on the part of many photographers to include as much of the subject as possible in their photographs necessitates the use of short-focus lenses in order to embrace as wide an angle as possible, with the result that many of the photographs produced are but feeble and unnatural representations of the objects depicted, whilst the narrower angle lenses, to which the photographers were in the earlier days confined, gave bold and natural effects. We have three examples before us as we write, made from half-plate negatives, and each taken from the same point of view, but with lenses of eight, ten, and twelve-inch foci respectively, and it is quite apparent that in the photograph taken with the twelve-inch focus lens we have the most natural rendering of the scene.

In many landscape subjects it is true that it is scarcely possible from the picture to tell whether a wide or a narrow angle objective has been enployed in taking the photograph, as in many cases the defects arising from the use of too wide an angle are not so noticeable as in others. The subjects which suffer the most are usually those which have the finest and boldest outlines. As an example, let us take almost any mountain scene, or a steep and rocky cliff, which makes a grand and impressive picture to the eye. It might be thought that a photograph of the scene taken from some particular standpoint would result in a splendid picture. Most of us, however, know from experience that with the ordinary apparatus the best photograph that we can produce will give no impression of the scene that we remember so well. All the grandeur of the scene has disappeared, the objects appear insignificant, and the production is disappointing. When looking at a scene we should try and analyse the effect that it produces. There are two ways of looking at any scene: the one consists of glancing from point to point in the endeavour to take in the general effect of all its surroundings; the other in looking at objects with the idea of finding pictures, in which case the eye fixes upon some principal object, which from its surroundings appears to give the harmony of form and contrast of light and shade necessary to produce a pleasing effect. If now we keep our eyes steadily fixed, and roughly measure the angle which is embraced, we shall probably be surprised at its smallness. It is seldom that a subject which is seen with sufficient distinctness to be taken into consideration in the choice of a picture embraces an angle of more than 15° with the axis of the eye; that is to say, that the greatest angle subtended by any subject which is seen at one time with sufficient distinctness to form a picture is about 30°, and sometimes even less.

In the example before us, taken with a twelve-inch focus lens, the angle embraced was 20°. It is not to be wondered at, then, if we include an angle of 50° or 60° when photographing mountain scenery, that the effect is lost; for the photograph which results will never be viewed from such a point as to cause the objects represented in it to subtend the same angle as the objects themselves did. To take in at once more than 20° or 30° of picture is just as impossible as it is to do so when looking at the objects themselves. As a consequence, it is found that most people when looking at a picture, except when they wish to examine its details, stand at a distance from it equal at least to two or three times its length. Now, in the case of a photograph taken with a lens whose focal length was equal to about the length of the picture, the result is that the mountains, or whatever else it may be, appear considerably dwarfed in size, and a totally false impression of the scene is conveyed to the mind. Most photographers are familiar with the feeling which prompts them to include a little more of the subject in their photographs. This results from not viewing the object as it should be viewed when it is to form the subject of a picture, but instead shifting the eye from one portion of the scene to another, with the result that very

often several pictures side by side are seen, any one of which, if treated separately, would often form a good subject for the camera, while the general effect as an extended view would probably be very disappointing. As photographers give more and more attention to the matter, it will probably be found that the most suitable focal length of lens for ordinary work will be at least equal to twice that of the length of the plates used.

ASCERTAINING THE FOCAL LENGTH OF A LENS.—A method for finding the focal length of a lens readily was recently described in *The British Journal of Photography* by Mr. A. Lockett, the procedure being as follows: Draw two vertical lines parallel with each other at the centre of the focusing screen, and at a distance apart of one inch exactly. Having done this, focus sharply some distant object, such as a church spire or a chimney, using the lens at its full aperture. Then very carefully mark off on the base board of the camera the position occupied by the focusing screen, or in the case of a camera focusing from the front, any convenient part of the front carrying the lens. When a pointer is fitted the position of that may be marked. Then measure off one inch exactly in advance of the "infinity" mark thus obtained, and extend the camera until the screen or pointer is against this second mark. Finally, fix up a foot-rule horizontally, and in such a position that its image will occupy the centre of the focusing screen; then move the camera bodily to and fro, without any alteration in its adjustments, until the image of the rule is seen sharply in focus at the full aperture of the lens. Then, if the zero of the graduations of the rule coincide with one of the pencil lines drawn upon the focusing screen, the focal length of the lens will be directly recorded on the ground glass by the extent of the scale included between the two pencil lines. Thus, if five inches of the rule is included in the image between the two pencil lines, then the lens has a focus of five inches. The rationale of the method is explained as follows: Let f equal the principal focus of the lens, and r the ratio between the size of the image and that of the object; then the distance from the lens to focusing screen will equal $f + \frac{f}{r}$. When the distance is one inch beyond the infinity mark, then $\frac{f}{r} = 1$ inch; but if $\frac{f}{r} = 1$ inch, $\frac{f}{r}$ will also equal $\frac{f}{f}$; $\therefore r = f$. Thus, if five inches of a foot-rule occupy the space of one inch on the ground glass the ratio is five; and as $r = f$, five inches is the focal length. As there is perhaps a chance of error in using such a short distance as one inch extension of camera and distance apart of the pencil marks on the ground glass, a greater one may be employed, as the same principle may be applied for any increase of extension of camera beyond the infinity mark, provided the distance apart of the pencil lines on the focusing screen be identical with it. For example, if four inches be marked off on the base board from "infinity," and the pencil lines on the screen be made four inches apart, then, when the image of the scale is sharply in focus, the focal length of the lens will be directly recorded between the pencil lines. Thus, provided the two marked distances be kept the same, they may be of any length desired.

PHYSICS.

By J. H. VINCENT, M.A., D.Sc., A.R.C.Sc.

COLLOIDAL GRAPHITE.—Colloidal graphite was invented by Dr. E. G. Acheson, who, in 1897, first produced artificial graphite on a commercial scale by the decomposition of carborundum in the electric furnace. The silicon of the carborundum is dissipated as volatile matter when the temperature is raised sufficiently, and the carbon is left in the form of pure graphite. The graphite is then reduced to powder, and passed through a sieve having forty thousand meshes to the square inch. The powdered graphite, although much finer than the finest flour, is still too coarse for lubrication purposes. It is next treated with a water solution of tannin, which has the effect of making the grains split into powder about a thousand times smaller. Graphite in this condition of fineness produces a lasting suspension or colloidal solution when added to suitable lubricating oils. The oil is rendered more efficient as a lubricant; and, if from any cause the supply of the lubricant to the bearing fails, the rubbing surfaces become protected by a layer of graphite, which postpones overheating. (W. W. Acheson, jun., *Chem. Eng.*, XII, No. 12,791.)

ULTRA-VIOLET RAYS AND ARTIFICIAL FERTILISATION.—Professor Loeb records in *Science*, November 6th, 1914, some remarkable experiments on the effect of ultra-violet light on the eggs of the sea-urchin. He exposed the unfertilised eggs to light from a quartz mercury arc lamp for ten minutes, and found that the majority proceeded to segment; by suitable treatment some developed into larvae, and some advanced beyond the gastrula stage. That the ultra-violet rays are responsible for these effects is proved by the fact that thin glass, which is opaque to these rays, prevents its occurrence.

THE MOSCICKI CONDENSER.—Many who have worked with the Leyden jar have longed for a glass condenser constructed on engineering lines. The Moscicki condenser is a Leyden jar designed for prolonged use and general robustness. It consists of a glass tube coated on both sides with chemically deposited silver, which is afterwards electro-plated. This method of forming the coating obviates any danger of air bubbles being enclosed between the coating and the glass, which would be a source of weakness. The tube is kept thin, except at the closed end away from the electrodes, near the edges of the silver coatings, where it is thickened in order to resist the greater electrical stresses in this region. In order to obviate surface leakage at the other end of the tube, the neck of the condenser is fixed inside a porcelain insulator, and the whole space is filled with an insulating compound, which covers the edges of the coatings. The condenser proper is mounted in a metal tube, the intervening space being filled with a solution of water and glycerine, which has a low freezing-point. This arrangement gives the unit a large surface for dissipating heat, an important matter when the condenser is employed on alternating current. A complete condenser, measuring 4-ft. 9-in. × 3-in. in diameter, has a capacity of ·005 mfd., and will withstand an electrical pressure of sixty thousand volts.

ELECTRICAL PRECIPITATION.—Clearing a small glass chamber of smoke by electricity discharged from points is often shown as a lecture experiment, and the large scale demonstration on town fog by Sir Oliver Lodge is also well known. The commercial aspects of the question are dealt with in a paper by Cottreli, an account of which is given by *The Electrician* for July 16th, 1915. Experiments, started in the University of California, grew with the financial aid of business concerns, and are now carried on by two research institutions mainly formed for the purpose. The apparatus consists of the modern high-tension transformer, which displaces the Wimshurst machine used in the early experiments in England.

The method has been successfully applied to the removal of dust and smoke from furnace flues, and Cottreli hopefully regards the possibility of its application to marine fogs. He outlines a method by which a ship would travel through a fog-cleared region which is cleared by apparatus connected with the ship.

RADIO-ACTIVITY.

By ALEXANDER FLECK, B.Sc.

THE LATE SECOND LIEUTENANT MOSELEY.—All those who have in any way endeavoured to keep abreast

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of the advance of modern physical science must learn with regret that Mr. H. G. J. Moseley has been killed in action at the Dardanelles. He was only twenty-seven years of age, but by his scientific work he had earned for himself a high place in the list of those who have contributed to the advance of knowledge.

He became most widely known by a series of papers which he published shortly before war broke out on the "*X* Ray Spectra of the Elements." One result of these papers was to substantiate experimentally the theory, which was first put forward some time previously by van der Broek, but which then received little attention, that when the elements are arranged in ascending order of atomic weights the electric charge on the atom is increased by unity for each successive element. This work of Moseley's was immediately recognised to be of great importance, and was a very material contribution to our knowledge of the structure of an atom.

Mr. Moseley's other important contributions include the determination of the period of average life of an excessively short-lived new member of the actinium series, and the determination of the average number of beta particles discharged in the transformation of the radium short-lived active deposit.

It is not possible for one who was not personally acquainted with him to speak fully of the work of Lieutenant Moseley, but little more than a superficial knowledge of modern physics is sufficient to enforce the conviction that in his death Britain has lost one of the most brilliant of the rising generation of scientific men.

BRITISH ASSOCIATION MEETINGS.—In Section A (Mathematics and Physics), immediately after the President's address, a discussion on the "Radio Elements and the Periodic Law" took place. It was opened by Professor Soddy, of Aberdeen, and the other speakers who took part in it were Sir E. Rutherford, Dr. Bohr, Dr. Lindemann, Dr. Whytelaw Gray, and Mr. Fleck. Professor Soddy reviewed the development of the subject, and announced the result of his determination of the atomic weight of lead from a large quantity of thorite. Nearly one hundredweight of the mineral was used, and about eighty grammes of lead chloride were obtained. The middle fraction of this gave a value of 207·69 in place of the 207·20 for ordinary lead. Sir E. Rutherford spoke on the work of the late Mr. Moseley, and on the confirmation that the "isotope" theory had received from the comparison of the x ray spectrum of lead with the γ ray spectrum of radium-B. Dr. Bohr and Dr. Lindemann made remarks from the mathematical standpoint, and took up antagonistic positions. Dr. Bohr asserts that isotopes should be both chemically and physically non-separable, whereas Dr. Lindemann maintains that they should be capable of separating by one, but not by the other, of these means.

Dr. Whytelaw Gray showed some most interesting photographs of the results obtained when large quantities of radium emanation are allowed to decay in capillary glass tubes. A black film is obtained, which is mostly radium-D; and, when chlorine or iodine is introduced, the material so obtained gives all the microchemical tests for lead. So far as his experiments go, they support the idea that radium-D and lead are isotopes. The writer's contribution was more from a chemical than a physical standpoint. He put forward the view that the chemical properties of an element are determined by two factors, of which the more important is the number of electrons in the outer ring of the atom. The number of positive unit electric charges on the nucleus also contributes, in a minor degree, to the chemical properties of the element.

The discussion was followed by a large audience, who displayed a great amount of interest.

RADIO-ACTIVITY AND GEOLOGY.—Another discussion took place in Section C (Geology) on the interrelation of the above subjects. It was "characterised by a certain liveliness," and most of the speakers displayed, not only a great amount of strength of scientific conviction, but also a facility for sarcasm and repartee. Sir E. Rutherford was the first speaker, and he was followed by Professor Joly, of Dublin, Professor Soddy, Dr. J. W. Evans, Dr. Teall, and Professor Sollas. The discussion practically turned on the interpretation of radio-active evidence relative to the age of the earth; and, as the amount of experimental evidence is very small compared with the scope of the conclusions deduced from it, there was great diversity of opinion expressed. It seems unfortunate that attention should be almost solely devoted to this very speculative branch of the subject, and that not a word was heard of those instances where geology gives us definite information regarding radio-active questions. For example, pleochroïc haloes which occur in mica crystals in certain rocks have been shown to be due to small inclusions of uranium or thorium. One far-reaching deduction is directly made from the fact that the haloes only occur with these elements, namely, that the property of radio-activity is possessed only by uranium and thorium, and their disintegration products. It is not a common property of all elements—merely possessed in an intensified form by the above-mentioned substances.

PERIOD OF IONIUM.—Ionium is a radio-element which is known to disintegrate very slowly, *i.e.*, its atoms on an average exist for a long time compared to those of radium, of which the period of average life is two thousand five hundred years. It is a matter of considerable difficulty to obtain an accurate estimate of the period of ionium, although it has been proved to lie somewhere between thirty thousand and two hundred thousand years. The measurements referred to in the preceding paragraph have enabled a more accurate estimate to be put forward than any hitherto made. From a simple equation of the form

$$R = \tfrac{1}{2}\lambda_2\lambda_3 R_0 t^2,$$

where λ_2, and λ_3 are the periods of average lives of ionium and of radium respectively, and R is the number of atoms of radium which have grown in time t from a certain quantity of uranium, which would have R_0 atoms of radium in equilibrium with it if a sufficiency of time were allowed. Two calculations give the close agreeing results for the period of average life of ionium of ninety-seven thousand and one hundred and four thousand years respectively.

AN α-RAY EFFECT.—A very interesting communication appears in the July number of *The Journal of the Röntgen Society*, in which Mr. F. Harrison Glew describes some observations which he has made on the alterations produced in mica by bombardment with radio-active rays. He found that when a very thin strip of mica was laid near radium for several weeks the mica became curved, the convex side being always nearer the radium. By a process of elimination it was proved that the effect was not due to β or γ rays, nor to radium emanation, but was caused by the α rays alone. When the mica strip is supported at its ends with the convex side upwards, it requires three hundred and fifty times its own weight to bend it straight again. Mr. Glew puts forward the explanation that the curving of the mica is due to an increase in volume consequent on a number of α particles being stopped by the mica, and so becoming ordinary uncharged helium atoms. This explanation is supported by the fact that subsequent heating in a vacuum produces a small quantity of gas which gives the helium spectrum.

Anyone reading this paper must be struck with the soundness and directness of its methods and reasoning, and also with the fact, which in scientific matters has been proved over and over again, that a great many observations of importance can be made with very little material and practically no apparatus.

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ZOÖLOGY.

By Professor J. Arthur Thomson, M.A., LL.D.

THE SURFACES OF THE BODY.—In his luminous book on "Disease and its Causes," in the Home University Library, Professor W. T. Councilmann makes a good point in emphasising the fact of the enormous size of the various surfaces in the body. In man the extent of surface within the lungs is estimated at ninety-eight square yards, and within the alimentary canal at between seven and eight square feet. An average adult has twenty-five trillions of red blood corpuscles, and the surface area of all these is about three thousand three hundred square yards.

PARASITES AND THEIR POISONS.—We have referred to the fact that a vigorous animal may harbour numerous parasites without seeming to be a bit the worse. But a delicate or enfeebled animal may be killed by them, and lack of vigour or something unwholesome in the diet may lead to an increase in the number of parasites. It has been known for long that intestinal worms sometimes cause nervous troubles. This was formerly attributed to irritation of the nerve-endings on the wall of the intestine, but it is now referred to the toxins which the parasites produce. Extracts of flat worms and round worms may serve to bring on the nervous troubles if injected into the subject. In working with these Dr. Demettre E. Paullian found that his finger-tips, nose, and eyes were affected. This indicates that the poisons can pass through the skin, and that they are volatile.

PRACTICAL IMPORTANCE OF EUGLENOIDS IN WATER SUPPLY.—Euglenoids are small flagellate infusorians, often possessed of chlorophyll, mainly restricted to freshwater. L. B. Walton has been recently investigating those found in the water supplies of Ohio, and indicates their practical importance. Some serve as "producers" (feeding on inorganic materials), and form a food supply for small Crustaceans, on which fishes again depend. Some multiply in prolific abundance, *e.g.*, in uncovered reservoirs, and give the water an unpleasant odour. This may be due to oil vacuoles liberated when the Euglenoids die and disintegrate, or it may be produced by the living organisms. A "violet" odour and a "fishy" odour may be distinguished. Pools are sometimes red with *Astasia* (*Euglena*) *haematodes, Euglena sanguinea, Euglena rubra*, and others. Euglenoids and the like can be killed off by using 0·4 pound of copper sulphate to a million gallons of water, but the author wisely remarks that it is "advisable to consult someone familiar with the process before undertaking purification by the copper-sulphate method."

SLIME SQUIRTING IN PERIPATUS.—This ancient type, with such a widespread representation throughout the world, has a unique way of ejecting a viscous fluid from the slime papillae in the mouth. Mr. Stanley Kemp, in describing *Typhloperipatus williamsoni* from the Abor Country, notes that the discharge was directed with considerable accuracy towards the objects by which the animal was irritated. The secretion was at first abundant, but after a day or so of captivity it was only after violent stimulation that the creatures could be made to squirt. "The viscous fluid rapidly solidified, and formed long strings of a rubber-like consistency, which adhered to everything with which they came in contact. That they never stuck to the animal itself was doubtless due to the special skin processes which in life give it such a deep velvety appearance." The actual feeding was not observed, but insects put into the box with the Peripatus were afterwards found dead, in nearly all cases overwhelmed by the viscous secretion, and firmly adherent to the earth with which the bottom of the box was covered.

PROPAGATION OF FRESHWATER MUSSELS.—It is well known that the larvae or glochidia of freshwater mussels (of which there are many genera) become temporarily parasitic on freshwater fishes, and that, with two or three exceptions, this is a necessary chapter in the life-history. Dr. A. D. Howard has been studying this linkage experimentally, and has reached some interesting conclusions. Some kinds of glochidia occur on many kinds of fishes; others will not grip except on one genus. Thus the yellow sand-shell (*Lampsilis anodontoides*) requires some species of Gar (*Lepidosteus*). Some fishes, such as the Sheep's-head (*Aplodinotus grunniens*), will harbour several species of larval Mussel; others are very insusceptible, and shed the larvae that moor themselves. The Gar is a voracious nuisance, a menace to other fishes. "The discovery that it is practically the sole host for one of the most desired of shells is perhaps not agreeable. As a rule, however, we have to take Nature as we find her; and for those who expect always to find a *raison d'être* for each creature this nursing of the yellow sand-shell by the voracious Gar will satisfy the belief that things are as they should be." Of more importance, however, is the demonstration that the linkages between glochidia and fishes are sometimes very specific. In some cases it is clear that it is not any fish, but only a particular kind of fish, that will serve.

ORGANIC ALTRUISM.—A broad survey of the realm of organisms shows that a very large proportion of time and energy is given over to activities which are not greatly, if at all, to the advantage of the individual. Borne on by impulses and instincts as imperious as hunger and thirst, how many animals spend themselves for their race! It is their meat and drink to do so, and Nature takes advantage of their capacity for self-forgetfulness. In some types it seems almost extreme. As Cresson says: "Everything for the species; everything through the individual; nothing for the individual." In Goethe's words: "Nature holds a couple of draughts from the tankard of love to be fair payment for the pains of a lifetime." The continuance of the race is often very costly, or even fatal, to the parent, and there is exhaustion of energies in securing the safety and sustenance of the young. It is a great fact of organic nature that, while competitive individualism pays up to a certain point, survival and success are also to those types in which the individual has been more or less subordinated to the welfare of the species. Part of their fitness is in being capable of self-sacrifice. This is part of Nature's strategy which man has not adequately appreciated.

BLOOD-SUCKING PARASITE OF NESTLINGS.—Messrs. Dutton and Todd discovered in 1904 the strange habits of the "Ver des Cases" (*Auchmeromyia luteola*) of Tropical Africa. The larva emerges from the floor of huts and sucks the blood of sleepers. Roubaud has also described a similar behaviour on the part of larvae which suck the blood of the relatively naked Aard-Vark and Wart-Hog. It is interesting to find that, so far back as 1844, Léon Dufour discovered that a larval fly (*Phormia sordida*) sucked the blood of young swallows in the nest. Roubaud calls attention to a recent confirmation of this by H. du Buysson, and he has himself been able to watch the suction on the human skin and on bared parts of the skin of guinea-pig and fowl. It cannot suck unless it is kept closely pressed against the skin of its host, as would readily occur in the nest. In the previous cases mentioned the sucking larva keeps its body erect, with the anterior end fixed and the posterior end free. Another bird-sucking larva has been recently reported by Rodhain from the nest of a sparrow (*Passer griseus*) in the Belgian Congo. In all the cases as yet known the first segment behind the head serves as an adhesive sucker: a wound is made by scratching with the hooks of the mouth, and the blood is drawn in by a suction-pump action of the invaginated anterior end. The larvae cannot move much, so the host must be at rest. It cannot bite through clothes or hair or feathers, so the host must be naked. The parasitism is temporary and intermittent (the larvae dropping off when gorged), and may be regarded as a step towards permanent cuticolous parasitism.

THE LARGEST SHARK.—Professor E. W. Gudger gives an interesting account of the whale-shark, *Rhineodon*

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typus, a huge and very rare fish, solitary in habit, and of wide distribution. It occurs in the Atlantic and in the Pacific, but its especial habitat seems to be in the Indian Ocean and contiguous waters. It may be over twenty feet long, and some of the estimates go up to forty-five feet. The general colour is greyish brown, with numerous white spots and vertical bars. The jaws are enormous, but the teeth are very minute, the largest being little more than a line in length. There may be six or seven thousand all together. The remarkable dentition and the peculiar straining apparatus of the gills suggest that it feeds on small pelagic creatures. It is one of the quietest and most inoffensive of animals, "the mildest-mannered shark that swims the seas."

SOFT-MOUTHED AND HARD-MOUTHED.—Professor William James divided mankind into tender-minded and tough-minded, and there is a similar deeply penetrating distinction among marine animals. It depends on the absence or presence of hard mouth-organs for gripping, cutting, and chewing. Sea-anemones, tube-inhabiting worms, bivalves, and many starfishes are typical soft-mouthed animals; fishes, cephalopods, gasteropods, regular sea-urchins, are typical hard-mouthed animals. It must not be thought that all the "toughs" are carnivorous; thus many gasteropods, like periwinkles and limpets, browse on the seaweeds; or that all the "tenders" are devourers of detritus, for the common starfish, for instance, is a voracious carnivore. The common *Asterias rubens* opens up mussels, devours the large whelk, does battle with the sea-urchin, and destroys it, and even succeeds sometimes in getting the better of fishes. No shore animal, Blegvad reports, is safe from *Asterias*, not even its own kith and kin.

BLACK ANTS AND WHITE ANTS.—There is a large black ant (*Megaponera foetens*) in West Africa which makes raids on the white ants, or Termites, and makes prisoners of their workers, or even of their soldiers. It goes about in bands—about a hundred strong—and, when interfered with, makes a loud hissing noise, or stridulation, audible five yards away. Mr. S. A. Neave notes that "when a raiding party is returning, only a certain number are laden, the advance and rear-guard and the individuals at the ends of the files usually having their hands free." Captain C. H. Stigand writes (almost certainly about the same species): "Every member of the party is carrying a Termite in his mandibles. Sometimes one sees the wounded being borne home in their midst, some of them bristling with hostile Termites, who have died with their jaws firmly embedded in their black foes. The victors do not disembarrass their friends' bodies of these appendages." The Termites defend themselves by squirting an irritant fluid on their enemies, and, as long as the supply of secretion lasts, it is very effective. When the secretion is exhausted the ants resume the attack.

LIFE OF ISOLATED PARTS.—Great progress has been made of recent years in the culture of tissues excised from the body. But it is far from easy to incorporate the results in our conception of life. There is an activity of the creature as a whole to be distinguished from the activity of its individual parts. The organism is like a firm which acts as a unity by the coöperation of the partners; and, just as a firm might die while its individual members lived on, so an animal may die as a whole while organs, tissues, and cells go on working. But the amazing fact is the familiar one that among the lower animals (and in most plants) a piece may regrow the whole.

Some time ago R. Legendre reported on the survival power of isolated parts, and we select a few instances. The heart of a dog has been known to beat four days after death, and a tortoise's for eight days. By irrigation of the heart, the period of survival can be greatly prolonged. The muscles of frog and tortoise may be made to contract ten days after removal from the body, and the smooth muscle-fibres of the intestine may contract a long time after the death of the animal. Blood-corpuscles may be kept alive in proper media for weeks, and even months. The spermatozoa of a bull may show active movements for twelve days, and it is believed that in many bats the spermatozoa remain alive within the uterus of the female from autumn till spring. Harrison has kept pieces of an embryo frog developing for several weeks in a drop of coăgulated lymph. Legendre and Minot have kept the nerve-cells of the spinal ganglia of dog and rabbit alive for four days by placing them in defibrinated blood, through which there bubbled a current of oxygen. Repeated washings of a piece of tissue count for much. Carrel and Burrows have kept cells of cartilage, thyroid, kidney, bone marrow, and so on, alive and multiplying in a medium of lymph. As these experiments continue, we are likely to be led to a more precise knowledge of the conditions of life, and practical applications are already being made. In 1911 Magitot grafted on to the injured cornea of a human eye a piece of cornea, which he got from an eye that had been excised seven days before, and preserved in serum. The graft succeeded perfectly.

INDEPENDENCE OF CELLS.—Since writing the preceding note, we happened to come across a very interesting lecture by Professor S. von Schumacher on what he calls "the individuality of the cell." The idea is that each cell retains a measure of independence, even when it is but one member of a huge organisation. In isolation from their normal associations, they may live on and exhibit characteristic activities. The author does justice to the work of Harrison, Burrows, Carrel, and others, and asks how much has really been proved. (1) Isolated cells and excised pieces of tissue can be kept alive in appropriate media for weeks or months. (2) They may exhibit characteristic capacities, such as ciliary movement, amoeboid movement, rhythmic contraction. (3) In some cases they may multiply by mitosis, but this is not frequent; there are only a few convincing cases of genuine growth. (4) A piece of embryonic tissue may go on differentiating, but a piece of differentiated adult tissue almost always relapses into indifferent tissue.

VOICES AND SONGS OF FROGS AND TOADS.—The first backboned animals to attain to voice-production were the Amphibians; and, though they have not perhaps had very much to say, they have cultivated their powers. There is great variety, which has been recently studied very carefully by Dr. Frank Overton. In an account of the frogs and toads of Long Island (*Science Bull. Brooklyn Museum*, II, 1914) he tells us of the distinctive calls and songs. Thus the common toad of Long Island (*Bufo fowleri*) has "a combination of a low whistle and a moan"; the common toad of the mainland (*B. americanus*) utters "a sweet, trilling whistle"; the squawk of the spadefoot (*Scaphiopus holbrooki*) is "like the groan made by a deep-voiced man having his tooth pulled"; the chorus of the cricket frog "heard at a distance sounds like the jingling of small sleigh bells," and close by "like the rattle of small pebbles poured upon a cement pavement"; the common tree-frog (*Hyla versicolor*) utters a loud musical trill, and now and again a note "exactly like the sound made by a hen turkey that is calling to her mates"; the spring peeper (*H. pickeringi*) whistles shrilly; the leopard frog (*R. pipiens*) says "croak" very slowly, "in an extremely low-pitched bass voice"; the pickerel frog (*R. palustris*) makes a soft sound like "a gentle musical snore"; the wood-frogs (*R. sylvatica*) heard at a distance "sound like a flock of barnyard ducks clucking, not quacking"; the note of the green frog (*R. clamitans*) "resembles that made by plucking a string on a harp or a bass violin"; the bull-frog (*R. catesbiana*) has a voice with a volume corresponding to the size of its body (over eight inches); "its sound resembles the bellowing of a bull." It is very interesting to find that there is so much individuality that Dr. Overton can pick out the species by the voice, as one knows birds by their calls. Striking also are the anticipations of the voices of many higher creatures.

CORRESPONDENCE.

DARWIN'S ALTERNATIVE.

To the Editors of "KNOWLEDGE."

SIRS,—The reviewer of my little book, "Rambles in Highways and Byeways," alludes to what he calls my "peculiar views." These have now been before the public for nearly thirty years. I have repeatedly had to state that *I* was *not* the originator of the assertion that species could arise *without the means of natural selection.* May I once more ask to be allowed to contradict the idea that I first offered this "view"? Indeed, such a phrase is only applicable to me in the same sense that it is my *view* that an oak tree bears acorns!

The author was Darwin himself. He first expressed it just eighty years ago (in the year in which I was born) when in the Galapagos Islands in 1835. There he found a *variety* of the common old-world rat, and observes: "I can hardly doubt that this rat is merely *a variety, produced by the new and peculiar climate and food to which it has been subjected.*" The words I have italicised (though he did not realise their significance at the time) he subsequently discovered to be of the root of his own *alternative explanation* of the origin of species, as we shall see.

In a precisely similar way, Mr. G. Bentham, in his first edition of the "Handbook," records *one species* only of the water-crowfoot, of which he writes: "Many of the forms it assumes are striking, and have been distinguished as species; but the characters, although, to a certain degree, permanent, appear at other times so inconstant, and even to depend so much on the situation the plant grows in, that we can only consider them as mere varieties."

On the other hand, Hooker, in his "Students' Flora," describes *eight species.* Like Darwin, Bentham did not see that his words really indicate the fundamental principle of evolution for we here see that the same "mere varieties" in Bentham's eyes become well-defined "species" in Hooker's. So that, while Bentham explains the *cause* of their evolution, Hooker supplies us with the *results.*

We have in the above few remarks *Darwin's alternative explanation of the origin of species without the means of natural selection*; for neither Bentham, nor Hooker, nor even Darwin himself, hints at any necessity for it.

In 1838 Darwin invented his "theory," as he calls it! but he never lost sight of the fact that natural selection was not the *only* "means," as he distinctly stated at the end of the Introduction to the "Origin," which appeared in 1859.

In 1868 he published his "Variation." In the second volume we find that by this time he had realised the importance of variation by response to the "direct action of changed conditions of life"; and he places the two on the same level of importance (Volume II, page 272). He, moreover, adds that natural selection has nothing to do with the *cause* of variations. On the preceding page (271) he tells us that sub-varieties can arise by the above method *without* the aid of natural selection.

Such, in brief, is the historical basis of my "view." All I can say is that from the appearance of the "Variation," in 1868, until to-day, I have never ceased to look for proofs of *both* of Darwin's "views," not only in the British Isles, but on the Continent, including South Europe and Malta, and in both North and South Africa. The result has been that I never discovered a single example of any variety or species of any plant whatever, which afforded the slightest evidence of having arisen by "means of natural selection"; whereas his alternative explanation (as given in the case of the rat) has unlimited proofs, both by *induction* and *experimental verification*, such being the only two methods of proving a theory, working hypothesis, or explanation to be true, known to science.

Darwin's alternative is now no longer a question of probabilities, but of positive facts. They have been published, but my reviewer does not appear to have read them; nor has he read Dr. Warming's "Oecology," for that author, usually regarded as the "pioneer of ecology," came to the same conclusion, in the same way, by studying living plants in order to see *what* and *how* they grow. His words are: "It seems to be beyond doubt that characters peculiar to growth-forms have arisen through *direct adaptation to the environment*, . . . and that, at the same time, the acquired characters have been fixed to a greater or less extent by heredity" ("Oecology," 1909, page 373).

As my book on "The Origin of Plant Structures by Self-adaptation to the Environment" was published in 1895, dealing with plants on similar ecological lines—though the word "ecology" was not then invented—Dr. Warming has honoured me by quoting from it in his text, and in the words italicised gives his own conclusions in the very terms I had used.

Let us hear what Darwin said about himself. Writing to Professor M. Wagner, in 1876, he says: "In my opinion, the greatest error which I have committed has been not allowing sufficient weight to the direct action of the environment" ("Life," Volume III, page 158). The following are his last words: "It appears that I formerly underrated the frequency and value of these latter forms of variation, as leading to permanent modifications of structure, independently of natural selection." Again and again Darwin was charged with "attributing the modification of species *exclusively* to natural selection" (even within the last month); so he refers to his words in the Introduction to the "Origin," and concludes: "This has been of no avail. Great is the power of steady misrepresentation; but the history of science shows that fortunately this power does not long endure" ("Origin," sixth edition, 1872, page 421). Darwin has gone, and his prophecy has not yet been fulfilled. Ridicule and even abuse have been showered on me any time during the last five-and-forty years, because writers *will* not *read* Darwin's works (especially the sixth edition of the "Origin") in any other light than that of *natural selection.*

The reader will now be surprised to hear that I fully explained all this in the book itself. If the reviewer had read it, he would have seen that he had no grounds for charging me with holding "peculiar views" ("Rambles," pages 275–79).

GEORGE HENSLOW.

BOURNEMOUTH.

ARE FUNGI DETERGENT?

To the Editors of "KNOWLEDGE."

SIRS,—Your note on "Nature Study in Autumn," with the lovely photographs, is of great interest to teachers taking that subject. Every autumn does not suit for making a collection of the larger fungi, but we neglect no opportunity. A few season since we had a lovely display, which was finally built on the top of a small book cupboard. After a night of frost the mushrooms began to go rapidly back to their elements, and left a sloppy mess on the top of the cupboard. When this was cleared away, it took all the paint along with it. We have often wondered whether this might not be another of the accidental revelations of useful properties. The collection included the common varieties of Agarics, *Boleti* and *Cantharelli.*

A. MACDONALD.

DURRIS PUBLIC SCHOOL,
BY ABERDEEN.

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THE FACE OF THE SKY FOR NOVEMBER.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 52.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Uranus. R.A.	Uranus. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Nov. 2	14 26·4	S. 14·5	10 26·9	N. 7·7	13 22·7	S. 6·7	15 19·2	S. 18·2	9 4·6	N. 18·4	23 21·4	S. 5·8	7 11·3	N. 21·9	20 57·8	S. 17·9
„ 7	14 46·1	16·0	14 49·6	S. 21·5	13 36·6	7·7	15 44·7	19·9	9 13·9	17·8	23 20·8	5·8	7 11·0	21·9	20 58·0	17·9
„ 12	15 6·3	17·5	20 11·2	S. 21·1	13 59·3	9·9	16 10·7	21·4	9 22·8	17·3	23 20·4	5·8	7 10·6	21·9	20 58·3	17·9
„ 17	15 26·7	18·8	0 17·3	N. 6·3	14 26·5	12·7	16 37·1	22·6	9 31·2	16·8	23 20·4	5·8	7 10·0	21·9	20 58·7	17·8
„ 22	15 47·5	20·0	4 19·5	N. 26·0	14 55·9	15·5	17 3·9	23·5	9 38·9	16·3	23 20·7	5·8	7 9·1	22·0	20 59·2	17·8
„ 27	16 8·7	S. 21·0	8 37·1	N. 18·9	15 26·8	S. 18·1	17 31·1	S. 24·2	9 46·1	N. 15·9	23 21·3	S. 5·7	7 8·1	N. 22·0	20 59·8	S. 17·8

TABLE 53.

Date.	Greenwich Noon. Sun. P	Sun. B	Sun. L	Greenwich Midnight. Moon. P	Mars.	P	B	L	T	Jupiter.	P	B	L_1	L_2	T_1	T_2
	°	°	°	°		°	°	°	h. m.		°	°	°	°	h. m.	h. m.
Nov. 2	+24·5	+4·2	24·2	+21·0	Nov. 2	+ 0·7	+17·1	349·7	0 3 *m*	Nov. 6	−25·2	+1·9	100·2	236·2	9 16 *e*	5 30 *e*
„ 7	23·6	3·7	318·3	+15·1	„ 8	1·0	17·8	292·3	3 59 *m*	„ 13	25·2	1·9	125·2	207·7	8 35 *e*	6 17 *e*
„ 12	22·4	3·1	252·3	−13·3	„ 14	2·6	18·3	235·1	7 54 *m*	„ 20	25·2	1·9	149·9	179·1	7 55 *e*	7 5 *e*
„ 17	21·1	2·5	186·4	−22·4	„ 20	4·0	18·8	178·1	11 48 *m*	„ 27	25·2	1·8	174·4	150·2	7 15 *e*	7 52 *e*
„ 22	19·6	1·9	120·5	− 8·1	„ 26	5·4	19·1	121·3	3 42 *e*	Dec. 4	−25·2	+1·8	198·8	121·1	6 35 *e*	8 40 *e*
„ 27	+17·8	+1·3	54·6	+14·9	Dec. 2	+ 6·6	+19·4	64·8	7 34 *e*							

P is the position angle of the North end of the body's axis measured eastward from the North point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. T is the time of transit of the zero meridian across the centre of the disc. In the case of Jupiter System I refers to the rapidly rotating equatorial zone, System II to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1 T_2 multiples of $9^h\ 50^m{\cdot}6$, $9^h\ 55^m{\cdot}7$ respectively. In the case of Mars apply multiples of $24^h\ 39^m$.

The data for the Moon and Planets in the Second Table are given for Greenwich Midnight, *i.e.*, the Midnight at the end of the given day.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving Southward at a slackening rate. Its semi-diameter increases from 16′ 9″ to 16′ 15″. Sunrise changes from $6^h\ 56^m$ to $7^h\ 49^m$; sunset from $4^h\ 32^m$ to $3^h\ 49^m$. There is now considerable solar activity, and a constant watch should be kept on the disc.

MERCURY is a morning star, being at greatest elongation 19° W. of Sun on 7th. Semi-diameter diminishes from 4″ to 2½″. Illumination increases from ⅛ to Full.

VENUS is an evening star, but badly placed, having been in superior conjunction with the Sun on September 12th. Semi-diameter 5½″, illumination nearly Full.

THE MOON.—New $7^d\ 7^h\ 52^m$ *m*. First quarter $13^d\ 11^h\ 3^m$ *e*. Full $21^d\ 5^h\ 36^m$ *e*. Last quarter $29^d\ 10^h\ 10^m$ *e*. Perigee $8^d\ 2^h$ *e*. Apogee 23^d midnight, semi-diameter 16′ 39″, 14′ 44″ respectively. Maximum librations 2^d 7° E., 7^d 7° N., 14^d 7° W., 20^d 7° S., Dec. 1^d 8° E. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon (see Table 54).

MARS is a morning star between Cancer and Leo, rising about 10^h *e*. Semi-diameter 4″, width of defective lune nearly 1″. The North Pole of the planet is now turned towards the Earth and Sun. The Vernal Equinox of the planet's northern hemisphere took place on October 19th, and the planet is in the part of its orbit that corresponds with early April on Earth.

JUPITER is an evening star, in Pisces; stationary on 15th. Equatorial diameter 45″, Polar 41″. Defect of illumination on East Limb 0″·4.

Configuration of satellites at 9^h *e* for an inverting telescope.

JUPITER'S SATELLITES.

Day.	West.	East.	Day.	West.	East.
Nov. 1	32 ○	14	Nov. 16	31 ○	24
„ 2	3 ○	24 1●	„ 17	⊙	234
„ 3	1 ○	234	„ 18	2 ○	134
„ 4	2 ○	134	„ 19	12 ○	34
„ 5	1 ○	43 2●	„ 20	⊙	124
„ 6	34 ○	12	„ 21	31 ⊙	4
„ 7	34½ ○		„ 22	32 ○	41
„ 8	432 ○	1	„ 23	341 ○	2
„ 9	431 ○	2	„ 24	4 ○	132
„ 10	41 ○	23	„ 25	42 ○	3 1●
„ 11	42 ○	13	„ 26	421 ○	3
„ 12	412 ○	3	„ 27	4 ○	312
„ 13	43 ○	12	„ 28	431 ○	2
„ 14	3124 ○		„ 29	432 ○	1
„ 15	32 ○	14	„ 30	341 ○	2●

The following satellite phenomena are visible at Greenwich:—$1^d\ 0^h\ 48^m$ *m* I. Oc. D., $9^h\ 56^m$ *e* I. Tr. I., $10^h\ 58^m$ *e* I. Sh. I.; $2^d\ 0^h\ 13^m$ *m* I. Tr. E., $1^h\ 15^m$ *m* I. Sh. E., $7^h\ 15^m$ *e* I. Oc. D., $10^h\ 19^m$ *e* III. Oc. D., $10^h\ 33^m\ 9^s$ *e* I. Ec. R.; $3^d\ 1^h\ 22^m$ *m* III. Oc. R., $5^h\ 27^m$ *e* I. Sh. I., $6^h\ 40^m$ *e* I. Tr. E., $7^h\ 43^m$ *e* I. Sh. E.; $4^d\ 0^h\ 44^m$ *m* II. Tr. I., $5^h\ 2^m\ 4^s$ *e* I. Ec. R

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$5^d\ 6^h\ 51^m$ *e* II. Oc. D., $11^h\ 49^m\ 31^s$ *e* II. Ec. R.; $6^d\ 4^h\ 32^m$ *e* III. Sh. I., $7^h\ 28^m$ *e* III. Sh. E., $11^h\ 27^m$ *e* IV. Sh. I.; $7^d\ 4^h\ 47^m$ *e* II. Tr. E., $7^h\ 1^m$ *e* II. Sh. E.; $8^d\ 11^h\ 45^m$ *e* I. Tr. I.; $9^d\ 0^h\ 53^m$ *m* I. Sh. I., $9^h\ 5^m$ *e* I. Oc. D.; $10^d\ 0^h\ 28^m\ 41^s$ *m* I. Ec. R., $6^h\ 12^m$ *e* I. Tr. I., $7^h\ 22^m$ *e* I. Sh. I., $8^h\ 30^m$ *e* I. Tr. E., $9^h\ 39^m$ *e* I. Sh. E.; $11^d\ 6^h\ 57^m\ 36^s$ *e* I. Ec. R.; $12^d\ 9^h\ 16^m$ *e* II. Oc. D.; $13^d\ 6^h\ 44^m$ *e* III. Tr. E., $8^h\ 35^m$ *e* III. Sh. I., $11^h\ 29^m$ *e* III. Sh. E.; $14^d\ 4^h\ 24^m$ *e* II. Tr. I., $6^h\ 49^m$ *e* II. Sh. I., $7^h\ 14^m$ *e* II. Tr. E., $7^h\ 17^m$ *e* IV. Oc. D., $9^h\ 38^m$ *e* II. Sh. E., $10^h\ 23^m$ *e* IV. Oc. R.; $16^d\ 10^h\ 56^m$ *e* I. Oc. D.; $17^d\ 8^h\ 3^m$ *e* I. Tr. I., $9^h\ 18^m$ *e* I. Sh. I., $10^h\ 21^m$ *e* I. Tr. E., $11^h\ 34^m$ *e* I. Sh. E.; $18^d\ 5^h\ 24^m$ *e* I. Oc. D., $8^h\ 53^m\ 10^s$ *e* I. Ec. R.; $19^d\ 4^h\ 49^m$ *e* I. Tr. E., $6^h\ 3^m$ *e* I. Sh. E., $11^h\ 45^m$ *e* II. Oc. D.; $20^d\ 7^h\ 24^m$ *e* III. Tr. I., $10^h\ 30^m$ *e* III. Tr. E.; $21^d\ 0^h\ 38^m$ *m* III. Sh. I., $6^h\ 53^m$ *e* II. Tr. I., $9^h\ 27^m$ *e* II. Sh. I., $9^h\ 44^m$ *e* II. Tr. E.; $22^d\ 0^h\ 16^m$ *m* II. Sh. E.; $23^d\ 5^h\ 53^m$ *e* IV. Sh. I., $6^h\ 23^m\ 0^s$ *e* II. Ec. R., $8^h\ 1^m$ *e* IV. Sh. E.; $24^d\ 0^h\ 48^m$ *m* I. Oc. D., $5^h\ 33^m\ 2^s$ *e* III. Ec. R., $9^h\ 56^m$ *e* I. Tr. I., $11^h\ 14^m$ *e* I. Sh. I.; $25^d\ 0^h\ 13^m$ *m* I. Tr. E., $7^h\ 16^m$ *e* I. Oc. D., $10^h\ 48^m\ 44^s$ *e* I. Ec. R.; $26^d\ 4^h\ 24^m$ *e* I. Tr. I., $5^h\ 43^m$ *e* I. Sh. I., $6^h\ 41^m$ *e* I. Tr. E., $7^h\ 59^m$ *e* I. Sh. E.; $27^d\ 5^h\ 17^m\ 36^s$ *e* I. Ec. R., $11^h\ 14^m$ *e* III. Tr. I.; $28^d\ 9^h\ 25^m$ *e* II. Tr. I.; $29^d\ 0^h\ 4^m$ *m* II. Sh. I., $0^h\ 16^m$ *m* II. Tr. E.; $30^d\ 9^h\ 0^m\ 41^s$ *e* II. Ec. R.

SATURN is a morning star in Gemini. Rises about 8^h *e*. Angle P$-7°{\cdot}1$, B$-24°{\cdot}1$. Polar semi-diameter 9″, Major axis of ring 45″, minor $18\frac{1}{4}$″. Eastern elongations of Tethys (every fourth given) $1^d\ 11^h{\cdot}1$ *e*, $9^d\ 0^h{\cdot}3$ *e*, $17^d\ 1^h{\cdot}5$ *m*, $24^d\ 2^h{\cdot}7$ *e*; of Dione (every third given) $7^d\ 4^h{\cdot}4$ *m*, $15^d\ 9^h{\cdot}4$ *m*, $23^d\ 2^h{\cdot}4$ *e*; of Rhea (every second given) $2^d\ 4^h{\cdot}3$ *m*, $11^d\ 5^h{\cdot}0$ *m*, $20^d\ 5^h{\cdot}8$ *m*, $29^d\ 6^h{\cdot}5$ *m*. For Titan and Japetus E., W. stand for Eastern and Western elongations; S., I. for Superior and Inferior Conjunctions. Titan $3^d\ 2^h{\cdot}2$ *e* E., $7^d\ 0^h{\cdot}4$ *e* I., $11^d\ 10^h{\cdot}5$ *m* W., $15^d\ 11^h{\cdot}4$ *m* S., $19^d\ 0^h{\cdot}4$ *e* E., $23^d\ 10^h{\cdot}5$ *m* I., $27^d\ 8^h{\cdot}5$ *m* W. Japetus $17^d\ 7^h$ *e* S.

URANUS is an evening Star. Semi-diameter $1\frac{3}{4}$″.

NEPTUNE is a morning Star in Cancer stationary on 5th. On 3rd R.A. $8^h\ 19^m{\cdot}5$, N. Dec. $19°{\cdot}3$, on 27th R.A. $8^h\ 19^m{\cdot}0$, N. Dec. $19°{\cdot}3$. Semi-diameter 1″.

COMETS.—Mellish's Comet, *a* 1915, may be seen in Orion, rising about 7^h *e* on November 20th. It was easily visible to the unaided eye in the Southern hemisphere in June, but has now become faint, and invisible without telescopic aid. It will be near Rigel on November 6th.

The following Table gives its positions at 12^h p.m.

	R.A.	S.Dec.		R.A.	S.Dec.
Oct. 31.—	$5^h\ 22^m\ 3^s$	10° 1′	Nov. 12.—	$4^h\ 52^m\ 46^s$	5° 59′
Nov. 4.—	5 12 33	8 45	,, 16.—	4 42 45	4 32
,, 8.—	5 2 45	7 24	,, 20.—	4 32 47	3 3

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
	°	°	
Oct. 31—Nov. 12	43	+ 22	Conspicuous shower.
Nov. 2 ...	58	+ 9	
,, 3 to 6 ...	61	+ 35	
,, 7 ...	77	+ 31	
,, 8 to 10 ...	58	+ 17	
,, 9 ...	105	+ 51	
,, 11 ...	108	+ 11	
,, 13 to 16 ...	150	+ 22	Leonids.
,, 17 to 20 ...	25	+ 43	
,, 21 to 28 ...	63	+ 22	Conspicuous shower.
,, 24 ...	79	+ 21	
,, 25 to 27 ...	155	+ 37	
,, 26 ...	161	+ 58	
,, 29—Dec. 1	44	+ 56	

GREENWICH TIMES OF MERIDIAN TRANSIT OF CERTAIN BRIGHT STARS.—These are given to facilitate the determination of time by observations with small transit instruments. The times for intermediate days may be obtained by simple interpolation. The Greenwich time of the stars crossing the meridians of other places may be obtained by expressing the

TABLE 54. Occultations of Stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Time.	Disappearance. Angle from N. to E.	Reäppearance. Time.	Reäppearance. Angle from N. to E.
1915.			h. m.	°	h. m.	°
Nov. 1 ...	WZC 639	7·1	—	—	2 30 *m*	324
,, 3 ...	p^3 Leonis	5·7	5 19 *m*	195	5 40 *m*	230
,, 4 ...	WZC 769	7·3	—	—	4 41 *m*	293
,, 12 ...	WZC 1359	6·8	4 54 *e*	101	—	—
,, 12 ...	BD$-21°{\cdot}5738$	7·0	5 54 *e*	103	—	—
,, 17 ...	51 Piscium	5·7	4 1 *e*	108	4 44 *e*	188
,, 19 ...	101 Piscium	6·2	3 30 *m*	86	4 25 *m*	239
,, 20 ...	ϵ Arietis (double)	4·6	6 33 *e*	101	7 29 *e*	209
,, 20 ...	WZC 176	6·7	6 40 *e*	29	—	—
,, 21 ...	17 Tauri	3·8	4 27 *e*	21	5 0 *e*	305
,, 21 ...	23Tauri	4·3	4 46 *e*	86	5 40 *e*	238
,, 21 ...	η Tauri	3·0	5 18 *e*	69	6 17 *e*	254
,, 21 ...	28 Tauri	5·2	6 3 *e*	89	7 2 *e*	232
,, 21 ...	27 Tauri	3·8	6 5 *e*	110	6 53 *e*	212
,, 23 ...	BD$+26°{\cdot}884$	6·8	—	—	9 5 *e*	298
,, 24 ...	139 Tauri	4·9	7 22 *m*	172	7 41 *m*	210
,, 25 ...	ϵ Geminorum	3·2	3 17 *m*	145	4 19 *m*	245
,, 26 ...	BD$+23°{\cdot}1744$	6·4	1 44 *m*	171	2 20 *m*	221
,, 28 ...	π^3 Cancri	5·6	4 21 *m*	116	5 40 *m*	307
,, 30 ...	35 Sextantis (double)	6·0	1 43 *m*	181	2 14 *m*	237

From New to Full disappearances occur at the Dark Limb, from Full to New reäppearances.

Attention is called to the occultation of the Pleiades on the evening of November 21st.

longitude of these places in time, diminishing them by 9ˢ·83 per hour, and proportionately for fractions of an hour, then applying the result to the tabular time—positively for West longitudes, negatively for East ones.

moment of solar transit at Greenwich.

DOUBLE STARS AND CLUSTERS.—The tables of these, given three years ago, are again available, and readers are referred to the corresponding month of three years ago.

TABLE 55.

Day.	ϵ Pegasi.	β Pegasi.	α Andromedae.
	N. Dec. 9° 29′.	N. Dec. 27° 38′.	N. Dec. 28° 38′.
	h. m. s.	h. m. s.	h. m. s.
Oct. 28	7 15 52·55 *e*	8 35 18·21 *e*	9 39 28·50 *e*
Nov. 7	6 36 33·31 *e*	7 55 58·99 *e*	9 0 9·34 *e*
„ 17	5 57 14·06 *e*	7 16 39·76 *e*	8 20 50·15 *e*
„ 27	5 17 54·82 *e*	6 37 20·50 *e*	7 41 30·93 *e*

SUN before clock Nov. 1, 979ˢ·12, Nov. 6, 979ˢ·49, Nov. 11, 959ˢ·04, Nov. 16, 917ˢ·80, Nov. 21, 855ˢ·93, Nov. 26, 773ˢ·89, Dec. 1, 672ˢ·79. These are the equations of time for the

VARIABLE STARS.—Stars reaching their maxima in or near September, 1915, are included. The lists in recent months may also be consulted (see Table 56).

TABLE 56. LONG-PERIOD VARIABLE STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m. s.	° ′		d.	
R Piscium	1 26 15	+ 2 26	7·0 to 14·0	344	1915—Nov. 23
X Camelop.	4 34 29	+74 58	7·3 to 13·1	142	„ Nov. 20
V Ursae Min.	13 37 10	+74 45	7·5 to 8·7	71	„ Dec. 17
R Boötis	14 33 27	+27 6	5·9 to 12·2	223	„ Nov. 30
T Draconis	17 55 6	+58 13	7·5 to 12·0	426	„ Dec. 9
R Aquilae	19 2 16	+ 8 6	6·2 to 11·2	335	„ Dec. 27
AF Cygni	19 27 40	+45 58	6·9 to 8·0	94	„ Dec. 7
U Cygni	20 16 59	+47 38	6·1 to 11·8	464	„ Dec. 4
R Vulpeculae	21 0 36	+23 29	7·1 to 13·6	137	„ Nov. 30
T Cephei	21 8 22	+68 9	5·2 to 10·8	387	„ Dec. 7
V Cassiopeiae	23 8 1	+59 14	7·1 to 12·6	229	„ Nov. 9
R Aquarii	23 39 26	—15 45	6·0 to 10·8	387	„ Nov. 15
V Cephei	23 52 21	+82 43	6·2 to 7·0	362	„ Nov. 14
R Cassiopeiae	23 54 15	+50 55	4·8 to 13·2	432	„ Nov. 27

Minima of Algol November $6^d\ 6^h\cdot2\ m$, $9^d\ 3^h\cdot0\ m$, $11^d\ 11^h\cdot8\ e$, $14^d\ 8^h\cdot6\ e$, $17^d\ 5^h\cdot4\ e$, $26^d\ 7^h\cdot9\ m$, $29^d\ 4^h\cdot7m$. Period $2^d\ 20^h\ 48^m\cdot9$.
Principal Minima of β Lyrae November $2^d\ 6^h\ m$, $15^d\ 4^h\ m$, $28^d\ 2^h\ m$. Period $12^d\ 21^h\ 47^m\cdot5$.

SOME PRESIDENTIAL ADDRESSES AT THE BRITISH ASSOCIATION.

By H. S. REDGROVE.

PROFESSOR W. M. BAYLISS's address to the Physiological Section on "The Physiological Importance of Phase Boundaries" was one of considerable interest, both to biologists and chemists. After pointing out the importance to physiology of that class of chemical reactions, known as "heterogeneous," in which the reacting bodies, as in colloidal solutions, form more than one phase, Professor Bayliss proceeded to deal with the phenomenon of "adsorption." "Practically any substance dissolved in water lowers the surface-tension present at the interface between the liquid and another solid or liquid phase with which it is in contact. Moreover, up to a certain limit, the magnitude of this effect is in proportion to the concentration of the solute. Therefore, as was first pointed out by William Gibbs, concentration of a solute at an interface has the effect of reducing free energy, and will therefore occur. This is adsorption." Professor Bayliss showed how, to some extent at least, adsorption was capable of explaining the catalytic action of enzymes, at the same time pointing out difficulties in the way of accepting this as the sole explanation. Another interesting suggestion made at the end of the address concerned the contractile process of muscle. He pointed out the difficulties connected with the view that the system present in resting muscle is of a chemical nature, at the same time suggesting that physical, rather than chemical, forces, and especially surface-tension, play the chief part in muscular activity.

* * * *

A criticism of compulsory elementary education, coming from Mrs. Henry Sidgwick, must have proved both a surprise and a disappointment to many members of the Educational Science Section. Mrs. Sidgwick's argument was to the effect that the element of compulsion tends to diminish or destroy the parents' interest in their children's education. Her argument was based upon observations relating to a limited area in a purely agricultural district in Scotland. The insecurity of so small a basis is obvious, Mrs. Sidgwick herself admitting that it was hardly adequate for any wide-reaching generalisation. No doubt in some cases compulsory education has had the regrettable defect Mrs. Sidgwick deplores; but one has only to consider the alter-

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native thereto—the number of children who would be deprived partially or wholly of the right of education by their parents—to decide without hesitation for compulsory education. At any rate, the law as it stands at present has a salutary effect in emphasising to parents that their children are not their property to do with as they please.

Towards the end of her address Mrs. Sidgwick criticised the spirit of the young people of the present day, less under authority, and indulging more in pleasures than those of the previous generation, and speaks of "the nobler spirit which the war has called out," and which may be hoped "to carry us into better ideals of life." It is a question of values, raising that of the ultimate end of existence. Mrs. Sidgwick's words read as though she had not considered the problem in this light, but had been content to accept a merely traditional solution thereto.

* * * *

The address of Professor Scott, President of the Economic Science and Statistics Section, dealt with the economic side of the European war, and the manner in which Great Britain has borne up to date the economic burden laid upon her. "From the specially economic point of view," he says, "war is waste and loss. Therefore it is obvious that we cannot work too earnestly or too unsparingly to bring about, as soon as possible, the cessation of that loss, and a return to normal conditions. No doubt here, again, organisation is required." The doctrine of *laissez-faire* is rightly condemned. But the word "organisation" has been the occasion of so much wild talk and journalistic clap-trap that a word of warning is needed. Professor Scott supplies it. "It would be a tragedy," he writes, "if, in the defence of liberty, freedom of enterprise and labour were sacrificed, for victory in war would be tantamount to the defeat of our national ideals."

REVIEWS.

CRYSTALLOGRAPHY.

An Amateur's Introduction to Crystallography.—By Sir W. P. BEALE, Bart., K.C., M.P. 220 pages. 136 figures. 9-in. by 6-in.

(Longmans, Green & Co. Price 4/6 net.)

The attention of the scientific amateur is generally directed towards "natural history" in preference to the more exact physical sciences, and the author of this book is correct in regarding mineralogy as a branch of the former. Mineralogy, however, especially on the crystallographic side, approaches the physical sciences both in methods and results; but, at the same time, it is the crystallographic aspect which proves a source of trouble to most amateurs. While the author's aim is to give an account of crystal morphology from the mineralogical point of view, he has not succeeded in avoiding those geometrical difficulties which are usually so disconcerting to the non-mathematical beginner; and, as few amateurs are so well equipped mathematically as the author, the book is not likely to be used much by the class of reader for whom it is intended. Nevertheless, the book will be very useful to professional students, as the treatment is original and more attractive than that in the larger textbooks.

A triclinic crystal, axinite, is first fully described, and then examples of the various systems are treated in order of increasing symmetry. This method of commencing with the pedial, or even the pinacoidal, class of the triclinic system, and then developing the classes of higher symmetry from these, is a commendable feature in modern crystallography, and has great advantages over the older methods by which the less symmetrical types were derived by truncation of the holohedral forms. In this connection it is unfortunate to find such terms as "hemihedral," "tetartohedral," and even "merohedral" still in common use, as they imply the validity of the latter method. The author rightly insists on the connection between crystallographic edges and axes of reference, but it might have been better if some of the technical terms, such as "zone," "face," and "form," had been more exactly defined, while the word "pinacoid" is used in a more restricted sense than is usual nowadays. It is strange to see the word "Stellung" untranslated, in view of the use of the English term "setting." There is some confusion on page 99, and several of the figures, notably 64a and 65a, are badly drawn.

The get-up of the book is excellent, and the type is unusually clear, though we notice some misprints in the symbols, as well as one in the equations at the foot of page 100.

A. S.

DOMESTIC SCIENCE.

Domestic Science.—By CHARLES W. HALE, A.K.C. Part I: 327 pages. 102 illustrations. 8-in. × 5½-in.

(The Cambridge University Press. Price 3/6 net.)

This is an excellent introductory textbook on physical science in general. Although its title will tend to restrict its use to those whose object in acquainting themselves with science is to furnish a basis for the rational conduct of domestic affairs, we can thoroughly recommend it to beginners, whether they approach the subject from this point of view or not.

J. H. V.

FORESTRY.

Studies of Trees.—By J. J. LEVISON, M.F., Lecturer on Ornamental and Shade Trees, Yale University Forest School. 253 pages. 8-in. × 5½-in.

(Chapman & Hall, 1914. Price 7/- net.)

In spite of the highly specialised office which he occupies, Mr. Levison has produced a very remarkably comprehensive little book. He describes it as "an all-round book, adapted to the beginner," and "recognises the vastness of the field he is attempting to cover"; but cover it he does in a manner which is, on the whole, excellent. After three chapters on how to identify trees, in which he gives succinctly the distinctive characters, range, soil, enemies, and value of more than forty of the chief trees of the United States, he has a chapter on the structure and requirements of trees; another—very well done—on what trees to plant on the lawn, in street avenues, in woodlands, or as screens; a sixth on the care of trees, dealing with injurious insects and fungi, pruning and repairing; a seventh on forestry; an eighth on the structure and other characters of common woods; and a concluding one on the use of trees educationally.

Of these the fourth is the weakest. "Evaporation" is used for transpiration, the taking in of carbonic acid gas from the air is styled "respiration," and a reference is made to the stomata of the roots, which are, as a rule, non-existent. Elsewhere there are a few unfortunate uses of names, *e.g.*, "blue beech" for the hornbeam, and "sycamore" for plane; whilst it is unfortunate that *Pinus rigida* is known as "pitch pine" within the States, when in all foreign trade that name is applied to *Pinus palustris*. It is not strictly true to say that juniper "grows in open fields all over the world"; nor do we now consider that "the gingko belongs to the yew family," or that "it is

therefore a very old tree." The description of the leaves of the black locust (*Robinia*) as " small, delicate, and fern-like " does not seem adequate or happy; and it ought to have been made clear on page 134 that it is not the tussock, leopard, or other moths, but their caterpillars, that do the mischief. These are, however, but trivial defects. The book is admirably illustrated, though it is unfortunate that the illustrations are sometimes rather divorced from their letterpress, as on page 93, where the leaf and flower of the tulip tree occur in the description of the sweet gum. This is apt to lead the unwary student astray.

It is a sad story that Mr. Levison has to tell of the American chestnut (*Castanea dentata*), nearly all the trees of which in the United States have been attacked within the last nine years by the fatal fungus, *Diaporthe parasitica*. The spores enter through any bark wound, and the mycelium lives in and destroys the cambium, thus killing everything above the point of attack. There is no known remedy; and, whilst the American species is apparently doomed, the Spanish and Japanese species, although highly resistant, are not immune.

G. S. BOULGER.

PHYSICS.

Elementary Experimental Statics.—By IVOR B. HART, B.Sc., F.R.A.S. 200 pages. 1 plate. 177 illustrations. 7-in. × 4¾-in.

(J. M. Dent & Sons. Price 2/6.)

This is a school textbook of experimental statics intended for pupils who have not yet commenced the study of trigonometry. Careful directions are given for performing thirty experiments by means of simple apparatus used in conjunction with a wooden frame-work. This frame-work is fully described in an appendix. Provision for testing the progress of the student is made by the inclusion of a number of arithmetical examples.

J. H. V.

Elements of Optics for the Use of Schools and Colleges.—By GEORGE W. PARKER, M.A. 122 pages. 64 illustrations. 7½-in. × 5-in.

(Longmans, Green & Co. Price 2/6.)

This is a textbook for beginners in geometrical optics, in which the subject is clearly treated on orthodox lines. The previous mathematical attainments demanded of the reader are of a modest description, so that the book could be read with ease by anyone having some acquaintance with elementary algebra, geometry, and trigonometry. It is well furnished with numerical examples, the answers to which are also provided.

J. H. V.

Experimental Electricity and Magnetism.—By M. FINN, M.Sc. 436 pages. 181 illustrations. 5-in. × 7½-in.

(Bell & Sons, Ltd. Price 4s. 6d.)

It has been well said that young physicists should be taught as if intended to be either researchers or engineers. The author of this excellent book treats his readers as if they already had in them the germ of research and the love of construction. This is true of most of the boys in the upper classes of a good secondary school; and, if they are taught on the lines of this treatise, they will imbibe knowledge in such a way that their interest in the subject grows with their progress, so that it will be a lasting pleasure and a real educational influence all their lives.

There are many differences between this book and the orthodox work on electricity and magnetism. Its illustrations are new, the student starts doing interesting things from the first, and the order in which the subjects are treated is that best suited for the experimental method of teaching. The whole book bears evidence of being written by a man whose heart is in his work, and who not only knows what he is writing about, but how it should be taught.

J. H. V.

Wireless Time Signals: Radio-telegraphic Time and Weather Signals transmitted from the Eiffel Tower, and their Reception.—Issued by the Paris Bureau of Longitudes. Authorised Translation, with Additional Tables and Data. 133 pages. 30 illustrations. 1 folding plate. 7-in. × 5-in.

(E. & F. N. Spon. Price 3s. 6d. net.)

This translation of the Official Handbook of the Bureau of Longitudes gives all the necessary information required by the amateur who desires to receive the Paris time signals and weather reports. Additional matter provided by the translators (E.K.S. and C.S.) includes an account of the convention by which Greenwich has been almost universally chosen as fixing the primary meridian for the world, a French-English vocabulary of words used in weather reports, and other useful data.

J. H. V.

NOTICES.

THE LATE PROFESSOR MINCHIN.—It was a source of great sorrow to the members of the Zoölogical Section of the British Association that Professor Minchin, the President, was unable to be present to read his address owing to his very serious illness, from which there was little hope of his recovering. We are now grieved to hear that he has passed away.

SECOND-HAND INSTRUMENTS.—We have pleasure in calling attention once more to Mr. C. Baker's Quarterly List of second-hand instruments of all kinds.

ECONOMIC ZOÖLOGY.—There are many hundreds of entries in the catalogue of books and papers on Economic Zöology (Number 70) which has just reached us from Messrs. John Wheldon & Company.

TELESCOPE OBJECTIVES.—The National Physical Laboratory, by desire of the Director-General of Munitions Supply, has prepared a series of calculations for the benefit of opticians who may be engaged in the manufacture of optical instruments from the crown and flint glasses now made by Messrs. Chance Brothers. The calculations are published in a paper, entitled " Constructional Data of Small Telescope Objectives," and is published by Messrs. Harrison & Sons, St. Martin's Lane, price 2s. 6d.

LECTURES AT THE HORNIMAN MUSEUM.—The London County Council has again arranged a series of free public lectures at the Horniman Museum, Forest Hill, at 3.30 p.m., which begins on October 2nd.

THE BIRKBECK COLLEGE.—Very many scientific workers of to-day look upon the Birkbeck College with gratitude and affection, and remember the help which, as the Birkbeck Institution, it gave to them. Then most of its work was done in the evening; and although in the words of the Calendar—the issue of which for the ninety-third Session is now before us—its character is almost entirely changed to a University College, yet instruction on the subjects for University degrees in Arts, Science, Law, and Economics is still afforded in the evening as well as the day. More extensive buildings would give a great stimulus to the work of the College and add to its public utility.

XUM